43-0144

TB 43-0144

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

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# PAINTING OF VESSELS

This manual supersedes TB 43-0144, 7 February 1985

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HEADQUARTERS, DEPARTMENT OF THE ARMY,

9 MARCH 1987

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**WARNING**

ALL SAFETY INFORMATION CONTAINED IN SECTION 2
OF THIS TB SHALL BE FOLLOWED AT ALL TIMES.

TECHNICAL BULLETIN

NO. 43-0144

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 9 March 1987

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## REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistake or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, U.S. Army Troop Support Command, ATTN: AMSTR-MCTS, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798. A reply will be furnished directly to you.

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## SECTION 1 GENERAL

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**1-1. Purpose.** The purpose of this bulletin is to provide information, instruction, and guidance on the preservation of US Army Watercraft in service and in storage paints and Cathodic protection. Satisfactory painting applied prior to issuance of this bulletin shall not be altered solely for the purpose of conformation.

**1-2. Scope.**

a. The information contained herein shall take precedence over all other preservation instructions except where deviation has been authorized by US Army Troop Support Command. Deviations will be granted on an individual basis.

b. The contents of this bulletin are applicable to all US Army Watercraft except those assigned to the US Army Corps of Engineers and Bridging Units.

c. This bulletin may be used as a procurement document and shall be used as the basis, for writing repair and maintenance specifications.

**1-3. Reporting of Errors.** You can help improve this bulletin. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Troop Support Command, ATTN: AMSTR-MCTS, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished direct to you.

**1-4. Definitions.** For the purpose of this publication, the following definitions apply to the terms use:

a. Active Service Craft. Craft which have been assigned to an installation, activity, or unit for operational used.

b. Atomization. Term used in spraying. Proper atomization is obtained when the spray pattern is kept wet and the film is continuous as the area is covered.

c. Blast Cleaning to White Metal. Blast cleaning to white metal is defined as blast cleaning which removed completely all visible mill scale, rust, paint, and foreign matter from the surface of the metal including pitted areas. The end result must be a light gray steel surface of uniform appearance.

d. Conventional Paints. Linseed oil, alkyd, phenolic, coal tar, and other common resin paints for purposes of this bulletin; vinyl, epoxy, and urethane are not considered conventional paints.

e. Dry-Stored Craft. Craft which are turned into depot stock and held in dry storage at storage points.

f. Finish Paint. The top coat of a paint system.

g. Hull. The exterior surface of a vessel extending from the keel plate to the bulwark cap or first deck.

h. Major Area. The boottop region, topsides, superstructure, deck, cabin, bulkheads, large hull area or other surface of considerable dimension.

i. Major Painting. The renewal of a paint surface or paint system on a major area.

j. Mil Thickness. The dry film thickness of a paint coat. Each mil equals one thousandth of an inch.

k. Paint Coat. The dry film thickness of paint applied in one coat and roughly equivalent to one mil thickness if brushed on.

l. Paint Surface. The painted surface of a structure consisting of the topmost layer of protective paint.

m. Paint System. The protective paint barrier that covers a painted structure, which may consist of pretreatment coat, primer coats, intermediate coats, and finish or top coats.

n. Pretreatment Coat. The wash primer or preprimer paint film applied under the regular primer paint coat, used for better bonding and corrosion control.

o. Primer. The undercoats of paint, generally containing corrosion inhibiting pigments which react chemically with the steel to form a corrosion resistant surface.

p. Scantling. In shipbuilding, sizes of structural parts, including frames, beams, girders, and plating, which must be adhered to according to specifications. Minimum scantling are prescribed for the various types and sizes of vessels by classification societies. Also, generally, softwood timber measuring less than 5" x 5".

q. Solvent Cleaning. The cleaning of surfaces with chemical solvents to remove oil and grease.

r. Spray Coat. A spray coat consists of one or more passes, depending on the paint, and should be considered as that amount of paint applied at one time just short of sagging, running, wrinkling, and orange peeling.

s. Surface Preparation. The thorough cleaning of a surface in order to insure positive bonding of the applied paint to that surface.

t. Surface Treatment. The application of coating pretreatment to a cleaned and bare metal surface to provide initial corrosion protection and adhesive bonding of the primer coats to the metal surface.

u. Topside. The freeboard area on the exterior hull surfaces of the vessel bounded by the waterline or antifouling paint limit and the bulwark cap rail or first deck, whichever is applicable.

v. Touchup Painting. The spot painting of injured paint areas to prevent the undercutting of existing paint by corrosion.

w. Undercoats. The underlying layers of paint below the finish coat.

x. Underbody. The exterior hull surfaces normally under water when vessel is afloat.

y. Vinyl Paints. Plastic resin coatings that have outstanding durability, flexibility, and corrosion resistance.

z. Wet-Stored Craft. Craft which are turned into depot stock and held in wet storage at storage points.

aa. Zinc Protectors. High purity zinc anodes attached to metal surfaces to provide corrosion protection by galvanic action in a water environment.

**1-5. Color Scheme.** Craft shall be painted with peacetime or mobilization colors as applicable. Tables 1 thru 3 of the charts contained in Appendix B prescribe colors for both situations.

a. Active Craft, Domestic Service. Craft assigned for active service within the continental United States will be painted in peacetime colors herein specified.

b. Active Craft, Oversea Service. Craft assigned to oversea commands will generally be painted in peacetime colors, except when mobilization colors are required by the oversea commander. Mobilization colors will then be applied as specified herein.

c. Craft Returned to Service. Craft returned to active service from storage and requiring major painting will be painted with peacetime colors unless otherwise directed.

**1-6. Retention of Color Scheme.** Color scheme in existence at time of receipt of craft from storage (whether peacetime or mobilization colors) shall be retained until major painting is required. The following categories of craft are affected by these requirements:

a. Stored Craft. Wet and dry stored craft which are painted in either peacetime or mobilization colors.

b. Excess craft. Craft which become excess to operational requirements, and are stored as replacement or mobilization reserves.

c. Surplus Craft. Surplus craft awaiting disposal. These shall be painted only to the extent required to prevent undue deterioration, i.e., touch up.

**1-7. Transition Of Paint Systems.** The decision to change paint systems shall be made only with prior approval from Commander, US Army Troop Support Command, ATTN: AMSTR-MCFM, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. Vessels presently coated with vinyl paint system should be scheduled for drydocking and painting during summer months, where possible.

**1-8. Cleaning.** All safety precautions outlined in Section 2 shall be complied with at all times. All cleaning shall be accomplished in accordance with Section 3.

### 1-9. Touchup Painting.

a. When to Paint. Touchup or spot painting shall be performed when less than 50 percent of the paint surface or paint system of a major area has deteriorated to the extent that the underlying structure is no longer protected.

b. Preparation. Deteriorated surfaces shall be cleaned in accordance with Section 3. Adjacent areas of intact paint shall have marine organisms removed and the edges feathered. The intact paint shall be cleaned in accordance with Section 3.

### 1-10. Major Painting.

a. When to Paint. Major painting shall be performed when more than 50 percent of the paint surface, or paint system of a major area has deteriorated to the extent that the underlying paint or structure is no longer protected. The 50 percent failure stipulation applies when several separate damaged areas add up to more than 50 percent of total surface, as well as when the damage is concentrated in one area.

b. Renewal of Paint Surface. When only the finish paint on a major area has deteriorated and the underlying paint is in good condition, new finish paint shall be applied over the intact undercoats.

(1) Hull surfaces shall be cleaned by brooming, pressure washing with fresh water, and by hand or power cleaning methods. Sound, adhering paint shall be left intact; loose, blistered paint, and deteriorated areas of old paint shall be removed. Old tightly adhering paint shall be featheredged sufficiently to permit the new paint coating to form a uniform and continuous surface.

(2) All surfaces to be painted shall then be cleaned in accordance with Section 3 and used as a base for new paint.

c. Renewal of Paint System. When the paint system on a major area has deteriorated through the primer coat, all existing paint shall be removed.

(1) Cleaning. The resulting bare structure shall be cleaned to remove all oil, grease, moisture, corrosion by products, and other surface contaminants in accordance with Section 3. The clean surface shall then be primed within eight hours after cleaning, to prevent rusting, as specified in applicable tables in Appendix B.

(2) Painting. Surfaces shall be painted in accordance with Section 5 through 7 and Appendixes.

### 1-11. Paint Film Measurement.

a. Touchup Painting. For touchup painting one brush coat shall be considered the equivalent of one mil, and two brush coats the equivalent of two mils of dry film thickness.

b. Major Painting. For major painting a film thickness gage shall be used to assure proper paint film thickness application. At least one random reading shall be taken at appropriate stages for each 100 square feet (9.3 square meters) of surface, or less, to determine conformity to minimum film thickness requirements of the applicable paint system.

c. Film Measuring Gages. Film measurements shall be accomplished by use of a measuring device which can be calibrated down to 0.0005 inch (0.0127 mm) and up to 0.020 inch (0.508 mm) in steps of 0.0001 inch (0.00254 mm).

### 1-12. Marking and Stenciling.

a. General. Block lettering and numerals conforming to figure 3 of Appendix D, shall be used for all exterior designation markings and draft numerals. All other lettering shall be Gothic capitals and all numerals shall be Arabic, unless otherwise specified herein. Generally, the color will be black on a white or light colored background, and white on a black or dark colored background. Gray paint is considered a light background.

b. Application of Exterior Markings. Exterior designation markings, draft numerals, and load line markings shall be applied as follows:

(1) Wood Hulls. Outlines shall be shallow scribe marks max 1/8 in. (3.16 mm) wide by 1/8 in. (3.16 mm) (deep) and shall be painted the same color as the lettering.

(2) Steel Hulls. Outlines shall be fine bead weld and shall be painted the same color as the lettering.

c. Stenciling and Hand Painting. Designation markings, draft numerals, life-saving and firefighting equipment identification box, locker contents markings, name boards, and special signs shall be applied by stencils, decalcomanias, or hand lettering. Decalcomanias for exterior surfaces shall conform to Specification MIL-M-43719-1/-2/-3; decals for all surfaces exposed to the weather shall conform to Specification MIL-M-43719. Paint for stenciled letters shall conform to Type I of Specification TT-P-98; paint for hand letters shall be enamel conforming to Class A of Specification TT-E-489.

d. Designation Markings.

(1) Self-Propelled Vessels.

(a) Bow. Designations shall be located on the hull or bulwark near the bow on both port and starboard sides in the sizes as shown on figure 4 of Appendix D. The legend shall be centered at approximately three-fourths the height from the designed load waterline to the upper edge of deck or bulwark. Where practical the data shall be arranged in two lines; when the alternate one-line arrangement is used the legend "US ARMY" shall be to the left of the vessel's number. If practicable, bow designations on tugs shall be located clear of permanently installed fenders guards and bumpers.

(b) Stern designation. "US ARMY" and name or number shall be located on the hull or bulwark. On vessels having transom or elliptical sterns, designations shall be centered horizontally on the vertical centerline plan through the hull. On vessels having a cruiser stern, designation shall be located near the stern on both port and starboard sides. On transom and cruiser sterns, designations shall be centered at approximately three-fourths the height from the designed load waterline to the upper edge of the deck or bulwark, whichever is higher. On elliptical sterns, designations shall be centered approximately midway between the fantail knuckle and the upper edge of the deck of bulwark, whichever is higher. Size of the stern designations shall conform to figure 4, column "A" of Appendix D.

(c) Nameboards. Nameboards shall be approximately nine (9) inches wide, one and one quarter (1 1/4) inches thick and of suitable length for name with three (3) inches border on each end. Nameboards shall be attached port and starboard on the side of bridge, or on rail, or lifeline stanchions on top of bridge. Nameboards shall be painted black with six (6) inch Gothic capital letters finished in gold color.

(2) Nonpropelled Vessel Shipformed Hulls. Nonpropelled ship formed vessels shall have the same exterior designation markings as self-propelled vessels.

(3) Barges With Long Deckhouses. If the length of the deckhouse is 40 percent or more of the overall length of the barge, the designation marking shall be centered on the port and starboard sides of the house. The designation marking shall also be centered on the forward and aft ends of the house. All markings on houses will be centered vertically at the midheight of the house or as near to midheight as possible. Sizes of designations shall be as shown on figure 4, Appendix D.

(4) Barges With Short Deckhouses. If the length of the deckhouse is less than 40 percent of the overall length of the barge, the designation marking shall be as specified in paragraph (5). Barges Without Deckhouses, except the stern designation shall be centered on the aft end of the deckhouse.

(5) Barges Without Deckhouses. Barges not having deckhouses, deck cargo bins or bulwarks shall have the designation marking centered longitudinally amidships on the port and starboard topsides. These designations shall be centered vertically 12 inches (30.48 cm) below the edge of the deck at side or 12 inches (30.48 cm) below the uppermost fender guard or rubbing strake. Sizes of designations shall be as shown on figure 4 of Appendix D. Where practical, these

same designations will also be centered on the bow and stern immediately below the deck edge. Where sufficient space is available, bow and stern markings will be the same size as those used amidships. If sufficient space is not available, they may be reduced in height to not less than one-half that specified for the amidships marking. Barges having deck cargo bins or bulwarks shall have the same designation markings, except, that they shall be located at the midheight of the deck cargo bins or bulwarks at the bow and stern and at amidships, port and starboard.

(6) Floating Cranes. Hulls of floating crane shall have designations as specified in (5) above for barges without deckhouses. In addition, the designation shall be centered on both sides on the crane cab. Size and form of designation shall be as shown on figure 4, Appendix D.

(7) Sectionalized, Knockdown, and Collapsible Craft. All sectionalized, knockdown, and collapsible type vessels shall have the applicable designation marking located as specified in paragraph (1) above, self-propelled vessels, except, where a specified legend on the side of the vessel would necessitate placing part of the legend on each of two or more sections. In the latter case, the legend and number shall be placed so that it is entirely shown on only one section.

e. Loadline Markings. Large self-propelled barges, tugs, and similar vessels requiring loadline certificates shall have loadline markings as allowed by their design and scantlings; and as specified in the ABS Rules for building and classing steel vessels; and in CG 176 as to location type, size, and application.

f. Draft Numerals. Draft numerals shall be used on all vessels, boats, or barges more than 45 foot (13.72 meters) load waterline (LWL). Numerals shall conform to figure 3 of Appendix D and shall be 6 inches (15.24 cm) high in vertical projection. Draft numerals are not required on vessels, boats, or barges of 45 foot (13.72 meters) load waterline length or less.

(1) Vertical Location. Draft numerals shall be so located that the bottom edge of each numeral shall establish the draft indicated by that numeral. Bottom edge of numeral shall be measured in exact feet normal to the designed load waterline and above the forward and aft reference points. Numerals shall extend from one numeral below the lightest draft, to one numeral above the deepest draft at which the vessel may float at bow and stern under extreme loading operations.

(2) Forward Draft Numerals. The forward draft numerals shall be placed port and starboard as near the forward perpendicular as practicable. The forward perpendicular, for the purpose of draft mark location, shall be considered as the vertical line through the intersection of the designed load waterline and the face of the stem. The reference point from which the vertical measurements for the forward draft marks will be determined, shall be the intersection of the forward perpendicular and the line passing through the aft reference point tangent to the lowest point of the keel or stem forward. For vessels with a straight horizontal keel, this line may be horizontal; for other conditions this line may assume any required angle.

(3) After Draft Numerals. The after draft numerals generally will be placed port and starboard as near the after perpendicular as practicable. On vessels with transom sterns they shall be located on the transom at the center

line of the vessel. The reference point from which the vertical measurements for the after draft marks are determined shall be the lowest point of the keel propeller guard, or stern frame; except that on those vessels where the propeller extends below the lowest extremity of the hull or appendages, the reference point shall be the lowest point of propeller circle.

(4) Draft Reference Marks for Wet-Stored Craft. Two white stripes 3 feet (91.44 cm) long by 4 inches (10.16 cm) wide shall be painted, using enamel conforming to Specification TTE-490, on each side of the hull, along the waterline of craft in wet-storage. The stripes shall extend from the bow aft port and starboard, and from the stern forward port and starboard.

g. Lifesaving Equipment.

(1) Lifeboats. Hull markings for lifeboats and other boats carried on board, except those having specifically authorized Army designations, shall consist of the legend "US ARMY" together with the authorized designation of the parent vessel. Designation shall be on the stern (port and starboard) if boat is double ended or, on the center of the transom if boat is transom sterned. The number of each lifeboat shall be stenciled or marked on the bow in numerals 3 inches (7.62 cm) high. The cubical contents and the maximum number of persons allowed to be carried in each lifeboat shall be marked or stenciled on each side of the bow in letters and numbers 1-1/2 inches (3.81 cm) high. In addition, the maximum number of persons allowed shall be plainly marked, or stenciled on top of at least two of the thwarts in letters and numbers 3 inches (7.62 cm) high. To ensure that markings will not be obscured when the lifeboat covers are installed, lifeboat markings shall not, in general, begin at less than 8 inches (20.32 cm) below the sheer line. The top of thwarts, side benches and footings of lifeboats shall be painted international orange conforming to Specification TT-E-489. The lifeboat releasing gear handle shall be painted gloss red (TT-E-489) and marked "Danger-Lever Drops Boat." The area 12 inches (30.5 cm) on a side surrounding the release lever shall be painted a contrasting white. All contents of the lifeboat not permanently affixed i.e., oars, paddles, masts, containers, etc., shall be stenciled with "US Army" followed by the vessel name or designation (LCU 1540) (PUSAN).

(2) Other Lifesaving Equipment. Lifeboats and liferafts shall have the legend "US ARMY" together with the authorized designation of the parent vessel clearly stenciled on them in letters 2 inches (5.08 cm) high, on the center of the front and back side or face.

(3) Color. International orange enamel conforming to Specification TT-E-489 shall be applied to wood and plastic surfaces of liferafts and liferaft covers of all vessels when, in the judgement of the commanders, a higher degree of visibility is essential to the accomplishment of assigned missions.

(4) Emergency Lights. Installed emergency lights shall be identified by stenciling the letter "E" adjacent to the light fixture. Portable emergency lights shall be stenciled with a number and the letter "E" on the light, adjacent to the light bracket. Portable lights shall be numbered similar to fire extinguisher described in paragraph h.(1) below.

(5) Emergency Gear. Storage lockers containing emergency gear shall be identified by stenciling the locker door or hatch as follows:

(a) Emergency Squad Equipment.

(b) Self-Contained Breathing Apparatus.

(c) Foam Storage.

h. Firefighting Equipment.

(1) Fire Station. All fire stations shall be painted red and have titles FIRE HYDRANT, FIRE VALVE etc., in 1-inch (2.54 cm) red letters above them on the bulkhead on which they are mounted. Fire stations shall be numbered consecutively fore to aft with even numbers to port and odd numbers to starboard. Portable fire extinguishers shall be numbered similarly on both the location and fire extinguisher. Fire hoses shall be stenciled "US Army Vessel" followed by vessel designation in black.

(2) General Alarm Bells. General alarm bells shall be painted red and have legend "GENERAL ALARM BELL WHEN BELL RINGS GO TO YOUR STATION" painted in 1-inch (2.54 cm) red letters beneath them on the bulkhead on which they are mounted.

(3) Crash Panels. Crash panels and emergency escapes shall have legend "EMERGENCY EXITS" painted on them in 2-inch (5.08 cm) letters in locations as follows:

(a) On compartment side of fire screen doors.

(b) On corridor side of stairwell doors.

(c) On inside of stairwell doors leading to boat deck. Color shall be that which is most legible against the color of the respective doors.

i. Piping Systems. Shipboard piping shall be identified by color coding and marking in accordance with figure 5 (Appendix D) and using the Navy Standard System. Color codes shall be applied to valve hand-wheels only. Valve stems, threads, and tags shall not be painted. Fire Hose racks shall be painted red. Color coded arrows indicating the direction of flow shall also be stenciled on the piping. The liquid within the piping system shall be identified by lettering which shall be applied when two or more fluids fall within a color i.e., hydraulic oil and lube oil tank vent and fill valves will be color coded. Exception is potable water lines which shall be painted light blue or striped with 6-inch (15.24 cm) light blue bands at fittings on each side of partitions, decks and bulkheads, at intervals not to exceed 15 feet (4.57 meters) in all spaces. The lettering together with arrows indicating the direction of flow shall be located at the following points on each piping system:

(1) Where entering or leaving mechanical equipment.

(2) Where appearing or disappearing through a deck or bulkhead.

(3) At all tee, cross, or wye branches of systems.

(4) At all valves.

(5) At any point which will clarify a complicated system. Piping system markings may be omitted for those locations where another marking on the same system is clearly visible from the specified location. Thus a straight run through a relatively small compartment need be marked only once and not at both bulkheads. Nonpotable fresh water line outlets shall be labeled as being unfit for drinking.

**NOTE**

**Fittings will not be painted.**

(6) Storage tanks shall be stenciled with the name of contents. Lettering shall be color coded and applied to the manhole cover or other visible location. Lubrication fittings shall be marked by the color coded letter "L" applied adjacent to the fitting.

j. Obliteration of Vessel's Markings. On vessels to be disposed of all exterior Army Designations such as "US ARMY", vessel's name and/or number, etc., shall be completely obliterated. Nameboards shall be removed from the vessel. To provide for future identification, builder's nameplates and other designative marking located within the interior of the vessel shall not be obliterated.

## 1-13. Corrosion Control

a. Cathodic Protection. Although coatings are used as the principal corrosion preventive on metal surfaces, a supplemental method of protection is needed for the underwater hull and appendages of ships to safeguard against paint failures, e.g., porosities, cracking, poor adhesion, abrasion, aging, and erosion. Cathodic protection (an electrochemical technique) can successfully arrest or control the corrosion of metals in a marine environment.

b. Cathodic Protection Systems. The types of cathodic protection used are as follows:

(1) Sacrificial (galvanic) Anode System.

(2) Impressed Current System.

c. Sacrificial Anodes System. A system based upon the theory that a less noble metal, when connected to a more noble metal in a corrosive environment, will generate a current of sufficient magnitude to protect the more noble metal. In so doing, it in turn is sacrificed. Such is the case, when magnesium, aluminum or zinc anodes, attached to a ship's hull slowly dissolve generating a current to protect the hull and its appendages against corrosion by eliminating local anodes and cathodes on the hull. The disadvantage with this type of protective system is the periodic replacement of the anodes are required.

(1) Sacrificial anode system installed, requires maintenence on a continuing basis. The system specified herein is designed to last 2 or 3 years to conform with normal overhaul periods. The actual service life is dependent upon a combination of many factors.

(2) During Drydock Overhaul (2 year schedule) the ship shall be inspected to determine the need for anode replacement. All anodes shall be replaced when two years or more have elapsed since the last drydocking involving anode replacement. Normally, stern anodes deteriorate more rapidly than those installed midships. However, this may not be the case where large bare metal areas may exist in the forward area due to beaching operations. In addition, the leading and trailing anodes usually deteriorate more rapidly than those in the center of the vessel. Therefore, spot replacement of certain anodes may be required from time-to-time without the expense of complete replacement of the system. As a general criteria, anodes should always be replaced when they are approximately 50 percent or more deteriorated.

(3) Anodes shall conform to type ZHS, ZSS or ZHC of MIL-A-18001. Their lower driving potential and current limiting characteristic, when providing protection to a steel surface are desirable properties. Although zinc anodes do not require dielectric shields, zinc should not be installed over a bare steel hull. The same coating system that is used to coat the hull should be applied beneath the zinc anodes to act as a barrier. Bolt-on anodes should be used to facilitate replacement, unless welding of anodes is specified. Anodes may be modified by drilling holes through the straps to accommodate studs welded to the hull, or preferably, the ZHC-type zinc (bolt-on type) should be used. Proper functioning of the anode depends upon complete immersion in sea water, a clean anode surface, and a positive contract between the anode and the surface requiring protection. Anodes shall not be attached to propellers, propeller shafts, strut arms, strut barrels, or on the exterior of the stern or strut tube fair-waters.

(4) Occasionally a zinc anode may develop an oxide film which renders it inactive. Although this is the exception rather than the rule, this inactive state can readily be detected by comparing the anode with others in the system. The inactive anode usually will have a hard to remove, dark grey or black film on the surface, however, the anode manufacturer's identification will still be prominent; such anodes should be replaced. A light colored soft deposit on the surface, even though quite thick, is normal and may be prevalent under conditions of low velocity.

(5) The quantity of anodes specified for the system shall be installed. The hull surface beneath the zinc should be properly coated with the complete anti-corrosive system specified for the hull. Attachment straps and painted areas blistered from welding shall be painted the same as the hull.

**CAUTION**

Do not paint the zinc anode surface, this will insulate the anode and stop the flow of current. Only use specified steel for studs, deviation from this will cause deterioration of the hull.

(6) Studs welded to the hull or bilge keels, for bolting zincs, shall be fabricated from mild or medium steel. Galvanized studs are acceptable. Monel or corrosion resistant steel shall not be used. Studs should be cut flush with the top of the nut to minimize turbulence in service.

(7) The following is an excepted rule to follow in determining quantity of zincs required under velocity conditions of active service. Two zincs of Type ZHS or four zincs of Type ZSS will protect 400 square feet (37.25 square meters) of freshly painted steel, or 200 square feet (18.6 square meters) of steel coated with paint one year old, or 100 square feet (9.3 square meters) of bare steel. This rule also applies to aluminum hulls. The distance between any two zincs will not be less than 2 feet (0.61 meters). No less than two zinc anodes equivalent to the ZHS type anode shall provide the protection to any steel hull boat.

(a) Midships Area. Two thirds the calculated quantity or zinc anodes, necessary to give complete protection, shall be equally divided into 2 rows on both port and starboard sides of the hull. Half the anodes for each side shall be installed butted end-to-end, long axis fore and aft on the forward end of each bilge keel and half on the aft end of each bilge keel. As an alternate method, the anodes may be installed port and starboard just beneath the turn of the bilge, butted end-to-end, long axis fore and aft. Half the anodes for each side shall be installed forward of midships and the other, aft of midships. Where practical, the rows shall be positioned to avoid passing over fuel tanks even though the rows become discontinuous. This precaution is taken to avoid "gas-freeing" the fuel tanks, in case welding is necessary to attach studs or straps for mounting the anodes.

(b) Stern Area. The entire stern system, or 1/3 the anodes necessary for the complete hull system, shall be butted end-to-end with the axis fore and aft. They shall be located along the centerline keel, or just beneath the turn of the bilge and divided equally between the port and starboard sides of the hull. If a large number of zincs are required for stern protection, it may be practical to increase the number of rows. However, in no case should the spacing between rows be less than four feet. Begin all rows at least five feet forward of the propeller plane and extend forward. Zinc shall be positioned so that the anodes are always totally immersed under light load.

(c) Sea Chests. Zinc anode protectors conforming to shape and size as necessay will be attached to interior of sea chest. No less than one ZSS or a 6 inch X 6 inch anode shall be provided for each sea chest or other appendage. If nonferrous sea valves are fitted in conjunction with steel sea chests, a medium steel protection sleeve, to serve as a waster piece, should be fitted inside the sea chest at the junction of the sea chest and the valve. The sleeve should project down into the sea chest and be long enough so that it can be removed for replacement through the valve opening once the valve has been removed, or alternately may be fitted in sections which may be removed from the exterior of the ship through the sea chest.

(d) Internal Bilge Areas. Each compartment where water is held shall be considered for cathodic protection. Zinc anodes should be installed in all bilge spaces which are subjected to water more than 50 percent of the time and in those areas which are susceptible to excess corrosion. One zinc anode (ZHS type) should be installed for every 250 square feet of steel surface. Bolt-on anodes should be used for this installation so that depleted anodes can readily be replaced by crew members. Anodes should normally be located on the garboard strake close to the centerline keel. Care should be taken to mask anodes when painting bilge spaces so as not to coat zincs. Optimum functioning of the anodes depends upon the zinc being completely immersed in water and the surface being free of paint and excessive grease and oil.

(e) Salt water pumps. Zinc anodes should be located as close to the base of the pump as possible to protect against excessive corrosion due to salt water leakage.

(f) Heat Exchangers and Condensers. Where required, zinc anodes of appropriate style and type must be installed.

(g) Dissimilar Metals Protection. Zinc anodes of an appropriate style or type should be installed at concentration of dissimilar metals (e.g. bilge pump strainers, valves and piping) which are immersed in, or frequently flooded with sea water more than 50 percent of the time. Install anodes near the dissimilar metal junctions.

(8) Cathodic Protection For Aluminum Hulls. Cathodic protection shall be applied to aluminum hull boats and ships in sea water. Zinc anodes conforming to MIL-A-18001 shall be installed, unless, specific approval is granted for other systems.

**CAUTION**

Magnesium anodes and mercury bearing aluminum anodes shall not be used on aluminum hulls. Deviation from this will cause accelerated deterioration of the hull.

(a) Corrosion protection for the hull and appendages shall be provided by type ZHS, or ZSS zinc anodes. The ZSS type anodes shall be used for small boats in lieu of ZHS anodes if, three or less ZHS anodes are required. Use two ZSS for each ZHS anode.

(b) Calculate the quantity of hull anodes required for 2 years.

$$N = \frac{6.5W}{1000}$$

N = No. of ZHS anodes
W = wetted surface area (sq. ft.)

(c) In addition to the hull anodes, one ZSS anode shall be provided for each 5 square feet, or the proportion of 5 square feet, for each sea chest or other areas of dissimilar metals.

(d) Internal bilge areas shall be protected by 1 square foot of exposed zinc surface for each 200 square feet of coated surface of 50 square feet of bare metal. Anodes of type ZHS or ZSS, shall be used as best meet the requirements of the area to be protected.

**CAUTION**

The nature of aluminum boats merits special attention for mooring locations, particularly next to steel ships, boats, buoys, and piers. Under these conditions it is essential that nonconducting mooring lines be used, as well as insulating camel sections to prevent electrical contact of the aluminum hull with a steel structure, since this could result in galvanic corrosion of the aluminum hull.

d. Impressed Currant (IC) System. In this system, the anode used is a relatively inert material such as platinum. The anode is connected to the positive terminal of a direct current voltage source. The structure to be protected (the hull) is attached to the negative terminal of the power source. The power source generates current flow from the anode to the hull, suppressing the natural tendency of the hull to corrode.

(1) Components of an IC system are:

(a) Power Supply.

(b) Controller.

(c) Anode.

(d) Reference electrode.

(e) Stuffing tube.

(f) Shaft ground assembly.

(g) Rudder ground (including stabilizer if installed).

(h) Dielectric shield.

(2) The five components required in the basic IC system are shown in Figure 1. The reference electrode (1) is mounted through the hull (2) of the ship and is exposed to the sea water. The anode (3) is also mounted through the hull and electrically insulated from it. A controller (4) is connected to the reference electrode. The controller delivers a control signal to one or more power supplies (5). The power supply creates a DC voltage which is connected to the anode and hull.

(a) It is known that the corrosion of a metal immersed in water is caused by a very small current flowing from one small area of the hull to another. The small areas where the current leaves the hull and enters the water are called "anodic"; while the small areas where the current enters the hull from the water are called "cathodic". Corrosion or rust occurs only at the anodic areas. When the entire hull area is considered, these small currents can add up to hundreds or even thousands of amperes.

(b) When the anode mounted on the hull is connected to the power supply voltage, it will deliver a current to the hull, which suppresses current flow from the small anodic areas and makes the entire hull "cathodic" and stops the corrosion on the hull.

(c) The reference electrode is insulated from the hull and does not receive any anode current. It is used to determine how much cathodic protection is provided to the hull. The controller uses the reference electrode signal to determine whether the power supply and anodes should deliver more or less current.

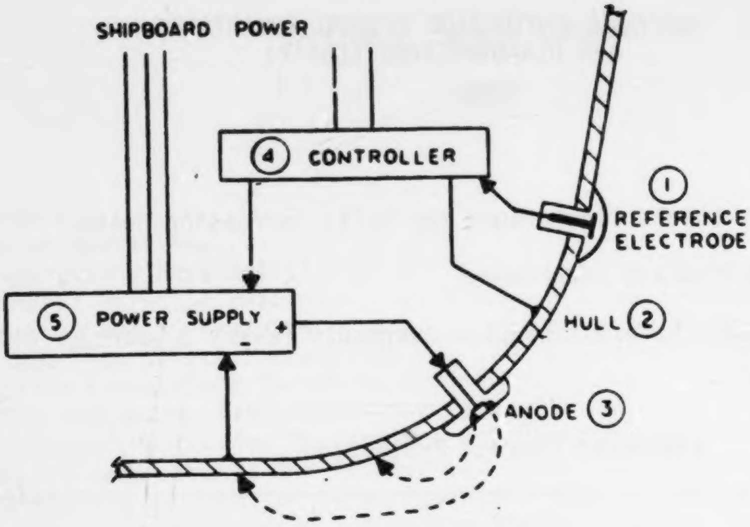

Figure 1. IC Block Diagram

(3) The IC system is designed to be fully automatic and to require a minimum amount of maintenance. Normal operating procedures usually involve maintaining a log of the controller reading and anode current, and a periodic cleaning of the slip ring on the propeller shaft. The operating log of the system provides a continuous record of the level of protection on the hull as well as providing a means of diagnosing any malfunction in the system.

TABLE 1. CATHODIC PROTECTION SYSTEMS ADVANTAGES AND DISADVANTAGES

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Galvanic (Sacrificial Anodes)

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ADVANTAGES

1. It can be used where there is no power available.
2. It is relatively foolproof and little supervision is required.
3. Installation is simple.
4. It is always active and is not shut down until the anode is consumed.

DISADVANTAGES

1. The current available is uncontrollable and depends on the anode area.
2. It is more costly if DC power is available.

## TABLE 1. CATHODIC PROTECTION SYSTEMS ADVANTAGES AND DISADVANTAGES (Con't)

DISADVANTAGES (Cont'd)

3. There is increased turbulent flow around the hull, increasing noise.

4. Drag and fuel consumption are increased.

5. Replacement is necessary before scheduled overhauls (every 3 years).

### Impressed Current Protection

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ADVANTAGES

1. There is relatively large availability of protective current, within the power supply operating range.

2. Operation is automatic (hands off), and there is continuous self-monitoring.

3. Exterior hull profile, noise generated, and drag are lower.

4. Weight is low.

5. Life cycle is limited by equipment damage (not wastage).

6. No replacement is required except for reference electrodes, which last 10 years.

7. Life-cycle cost to maintain is low.

8. Function of the system can be checked remotely.

DISADVANTAGES

1. Continuous DC power must be available.

2. More technical and trained personnel are necessary for supervision.

3. Initial cost is higher.

4. Logkeeping is required.

5. The system is frequently shut off in port, resulting in periods of no protection for the hull.

## SECTION 2 SAFETY INFORMATION

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**2-1. General.** This section contains safety precautions for all aspects of paint handling and operations except for stowage. The storage of flammable and combustible liquids shall meet the requirements of National Fire Protection Association (NFPA) Flammable and Combustible Liquids Code, NFPA 30.

**2-2. Painting Operations.** The two most important factors with regard to a safe painting operation concern responsibility and training. Their importance shall be firmly established and clearly understood by all supervisors and personnel handling or applying any materials.

a. Responsibilities. At the level of actual operations, line supervisors are responsible for all operations; the gas-test and safety personnel are responsible for providing staff assistance to the line supervisors. The responsibility factor is also particularly important at those supervisory levels where painting work is coordinated with other types of work.

b. Training. Commensurate with their responsibilities and participation, all personnel connected with these operations shall be made aware of the hazards associated with the handling and use of flammable materials, as well as the appropriate safety precautions. This information shall be part of each individual's job training.

**2-3. Supervisory Responsibilities.** The supervisor shall lay out the work and manage projects in such a manner as to produce the safest possible conditions. Personnel safety is the supervisor's prime responsibility. A safety checklist shall be used before a job gets underway. In addition, all supervisors shall adhere to the following program.

a. Always be aware of potential hazards in the area.

b. Be sure that each painter understands and accepts personal responsibility for safety and is informed of all safety rules.

c. Be sure that all safety measures have been taken before each work shift begins.

d. Insist that crewmembers work safely. Use disciplinary action in accordance with existing personnel directives, if necessary.

e. Be sure that all equipment meets safety standards. Use non-sparking tools in fire-hazardous areas. Anticipate possible risks with new types of equipment. Secure expert advice on potential hazards in advance.

f. Encourage personnel to discuss the hazards in their work. No job shall proceed if any question about safety remains unanswered. Be receptive to their ideas and suggestions; their field experience can be a source of information that will help prevent accidents.

g. Set a good example for the crew by demonstrating safety awareness in personal work habits.

h. Ensure personnel are using the proper respiratory protection for the hazard. A false sense of security can be created by using the wrong respirator. In addition, all personnel must be trained in how to wear respiratory protective equipment. An industrial hygienist or safety personnel should be consulted prior to start of work.

i. The following is an example of a supervisor's safety checklist.

(1) NO SMOKING signs posted.

(2) Warning tags and signs posted.

(3) Required protective clothing and safety shoes.

(4) Required eye protection, available as needed.

(5) Required respiratory protection, available as needed.

(6) Buddy system setup, if warranted.

(7) Safety belts, harnesses, and tending lines, on hand as required.

(8) Toxic material control, as needed.

(9) Burn hazards (chemical, hot pipes, other).

(10) Falling objects.

(11) Moving objects, cranes, and other traffic considered.

(12) Location of safety showers and eye baths.

(13) First aid materials on hand.

(14) Location of fire alarm station.

(15) Fire extinguishers and fire blankets, on hand as required.

(16) Location of nearest telephone.

(17) Barracades, as necessary.

(18) Electrical hazards in vicinity taken into account.

(19) Working electrical equipment grounded.

(20) Sparkproof tools, as required.

(21) Flammability of flashpoints of painting materials, nearby stowed materials.

(22) Safety and fire permits secured.

(23) Gas Free Engineer's approval secured.

(24) Condition of ladders and scaffolding checked.

(25) Safe footing provided for workers.

**2-4. General Painting Hazards.** Every painting operation exposes maintenance personnel and others in the area to conditions and situations that are actually or potentially dangerous. Use of toxic and flammable materials, pressurized equipment, ladders, scaffolding, and rigging presents potential hazards. Hazards may also be inherent in working conditions or caused by operator inexperience, lack of training, or carelessness. Awareness of all potential hazards is therefore esential, because continuous and automatic observance of precautionary measures will minimize the danger and improve painting crew efficiency and morale. The following areas require alertness when painting operations are planned and executed.

a. Paint Materials. Most paint materials are hazardous to some degree. All except water-thinned paints are flammable, many are toxic, and others can irritate the skin.

b. Environment. Working conditions will vary from job to job. In addition to the hazards inherent in the painting operation, the painter may encounter other hazards in the work area itself. For example, slippery decks or obstacles located on deck may cause falls; electrical or mechanical equipment may produce shocks or other serious injuries; uninsulated steam lines or hot pipes may cause severe burns, fire hazards, or too rapid evaporation of solvent, thus creating a toxic atmosphere.

(1) The working environment shall be studied before painters are sent into any work area. Hazards such as poor ventilation, noxious fumes, high temperatures, types of material and how they are applied, and the type of space where the work is to be done shall be considered. Before painters are allowed to enter the working area, they shall be protected by devices that will allow them to work in safety.

(2) Special action is required if any of the following conditions exist.

(a) If oxygen concentration is less than 19.5 percent.

(b) If combustible gas meter readings show differences between the work space and outside air.

(c) If it is impractical, with on-hand equipment, to test the workspace atmosphere for known or suspected toxic vapors or gases (such as bilge gases, distillate fuels, kerosene, or Navy standard fuel oil).

c. Painting Crew. Lack of training, experience, or knowledge of hazards on the part of any painter produces a possible threat to the safety of the ship, painting crew, and others in the painting area. Carelessness of any painter will also increase hazards. Shortcuts often produce unsafe working conditions resulting in accidents, personnel injuries, and loss of time and materials. An element of risk is present even when well trained workers follow all prescribed safety procedures. Observance of all safety precautions at all times will reduce this risk to a minumum.

d. Equipment. Ladders, scaffolding, and rigging must be used for areas not readily accessible from the deck, pier, or dock. Pressure equipment is often used to prepare surfaces and to apply paint. All of this equipment can be hazardous if handled carelessly. Proper equipment setup, dismantling and cleaning, required safety checks, and observance of basic precautions for handling equipment may require more time than actual use of the equipment. Nevertheless, precautions shall never be omitted.

e. Respiratory Protection. Personnel shall wear the proper type of respirator in hazardous areas. All devices, shall be approved by the National Institute for Occupational Safety and Health (NIOSH) and Mining Safety and Health Administration (MSHA) Respirators shall be selected, used, maintained and stored in accordance with TB MED 502, Respiratory Protection Program.

f. Exhaust Systems. When exhaust systems are used, the system must pull vapors or gases from the bottom of the tank or area in which the work is being done. The hazard potential of stagnant areas and pockets shall be recognized. A crewmember shall never work alone in a hazardous area. Exhaust system discharges shall be arranged so that the contaminated air will not create health hazards in surrounding areas.

g. Ventilation. If ventilation is required, outside air shall be provided at a minumum no less than that required to provide a safe, life supporting atmosphere. If such ventilation is not possible , respiratory protective equipment shall be provided. Equipment required shall be determined by an industrial hygienist, medical personnel, or safety personnel.

h. Eye Protection. "Suitable eye protection shall be provided and worn where machines or operations present the hazards of flying objects, chemical splashes or mists, caustic substances, or any condition considered hazardous by the supervisor or the operation." Safety eyewear shall be kept clean and available. Crew members working with chemicals shall wear chemical safety goggles.

(1) If there is a chance of liquids splashing in crewmember's faces, a full face shield should be used.

(2) "Portable eyewashes capable of providing 15 minutes of continuous irrigation to both eyes simultaneously with a flow rate of not less than 0.4 gallons per minute (GPM) shall be available."

i. Degree of Hazard. Each supervisor is responsible for ensuring that special precautions are taken, designating the equipment required, and advising the crew of the specific hazards of each job. Ignoring these hazards will increase the odds that accidents will occur. Relaxing of precautions in one job will inevitably lead to carelessness in subsequent jobs, regardless of the degree of hazard, eventually resulting in an unnecessary increase in accident rates.

**2-5. General Safety Measures.** Potential hazards that exist in all painting operations make a continuing and enforced safety program essential. A good safety program that has adequate safety procedures will provide protection against the three major types of hazards: accidents, fire, and toxicity. All personnel shall observe all established precautionary measures and safety rules, and shall be thoroughly familiar with all safety measures.

a. General Health. Only personnel not sensitive to heights shall work on ladders, scaffolding, or rigging. Painting crews shall be composed of personnel who have a proper attitude toward safety and who are in good physical condition. The medical examiner shall determine that employees are physically able to perform work and use the respirators.

b. Protective Clothing. Personnel shall wear adequate clean clothing and gloves to prevent skin contact with painting and cleaning materials. Clothing with cuffs, loose pockets or rips, and loose ties and jewelry shall not be worn since they are potential causes of hangups. The following precautions shall be adhered to with regard to protectivae clothing.

(1) Gloves and safety helmets shall be worn during abrasive blasting.

(2) Hardhats and steel-toed safety shoes shall be worn wherever there is possible danger from falling objects.

(3) Nonskid, rubber-soled shoes shall be worn for work in enclosed spaces or where flammable vapors may be present (spark prevention).

(4) Acid-proof clothing shall be worn when handling acid or caustic cleaners.

(5) Acid-proof, air-supplied suits shall be worn when using acid or caustic cleaning materials in enclosed areas.

c. Buddy System. Personnel shall never work alone in hazardous areas. At least two crew members shall be assigned to such jobs with at least one additional person available for rescue work, should the person in the tank be overcome. (Personnel performing such duties shall be properly trained to perform tank rescue work. Additional personnel with such training should be available.) These individuals shall be in communication with each other at all times during operations in hazardous areas. If an accident occurs in a tank or other confined space, the crewmember stationed on the outside must never enter the tank to give assistance alone, but, shall seek the help of the additional person available for rescue work. Multiple deaths have occurred from failure to follow this basic precaution. Personnel entering tanks shall be equipped with suitable approved respiratory protective equipment, lifebelts or harnesses and lifelines. If the accident happens outside a confined space, the other crewmember can seek help or come to the aid of the injured one.

**2-6. Inspection Safety Precautions.** Safety precautions that shall be taken to ensure personnel safety during inspection of tanks , voids, and other hazardous areas to be painted.

a. Pre-Entry Requirements. Do not enter any enclosed or poorly ventilated space until a gas Free Engineer has certified that the space is free of noxious fumes and flammable gases and sufficient oxygen is present. Station a crew member outside before entering any confined space such as a tank or void.

b. Safety Equipment. Use necessary safety equipment. This may include hardhats, safety glasses, steel-toed rubber-soled footwear, gloves, coveralls, respirators, explosion-proof lights, and safety harnesses. Lifejackets and safety harnesses shall be worn when working near or over water. Lifelines shall have no more than 2 feet of slack so that the jolt from a fall will not cause injury.

c. Personnel Health. Do not smoke, eat, or drink inside a tank or other hazardous area. Wash hands and face thoroughly before smoking, eating, drinking, or using the toilet. Obtain medical attention immediately for fume inhalation and for any cuts or abrasions that are incurred during the inspection of these spaces.

**2-7. Safety Precautions for Paint Mixing.**

a. Shore Facilities. The mixing area shall be adequately ventilated to prevent personnel overexposure to solvents and other toxic materials. If possible, detached shops or temporary structures shall be provided for paint mixing and for storing paint buckets, brushes, and rags. Permanent structures created for paint mixing and storage shall be equipped with automatic sprinklers. Signs reading "NO SMOKING IN OR AROUND THIS BUILDING" shall be posted conspicuously inside and outside each paint shop or other building in which paint is used, mixed, or stored. Only the quantity of solvent and paint needed for one workday shall be taken into the mixing area.

b. Afloat. Paint shall not be stowed in the mixing area. Mixing of paints, varnishes, lacquers, and their solvents shall be confined to the paint mixing room or other designated compartments. Paint products shall not be mixed in a closed compartment without adequate ventilation. Posted barricades or other suitable measures shall be provided to ensure that there is no smoking, open flame, or hot work within mixing compartments or in adjacent passageways.

**2-8. Fire Prevention Precautions for Paint Mixing.** Smoking, open flames (such as matches and torches), and hot work are prohibited in or near the area where paint, varnishes, lacquers, and their solvents are mixed. Spilled paint or solvents must be wiped up immediately to reduce fire and vapor hazards. Rags or other materials used for paint clean-up shall be placed in a closed-top metal container for disposal. Specific fire prevention precautions are described below.

a. Electrical Equipment. In rooms where extensive paint mixing operations are carried on, electrical equipment shall be installed in accordance with Class I, Group D requirements of the National Electrical Code. Explosion-proof lamps with shatterproof lenses shall be used for lighting.

b. Firefighting. Authorized personnel, duty fire party, and damage control party using the mixing room, shall be informed of the location and instructed in the use of the firefighting equipment to be used on paint or paint-related fires. The firefighting equipment shall be readily accessible and escape routes from the area shall be prominently designated.

**2-9. Personnel Protective Precautions for Paint Mixing.** These precautions apply to paints in general. Skin contact, eye contact, ingestion, and breathing mists or vapors in excess of the threshold limit value (TLV) shall be avoided.

a. Personnel Precautions. Personnel with a history of chronic skin disease, allergies, or asthma shall not be permitted to work with paint compounds and thinners. Personnel who are sensitive to paint compounds and thinners shall be reported to the medical department. (Para 2-10).

b. Persons handling painting materials shall avoid contact of material with skin and eyes, and inhalation of mists or vapors. No food nor drink shall be allowed in the paint area. When painting materials are handled, care shall be exercised to wash hands before eating, drinking, smoking, or using toilets.

c. Accidental Ignition. Extreme care shall be taken by persons mixing solvent-based paints to remove from their person all possible sources of ignition, such as matches, cigarette lighters, and steel buckles. Personnel shall wear nonskid, rubber-soled shoes or canvas boots, over their shoes, when working in an enclosed space or where flammable vapors may be present. Plastic clothing shall not be worn.

d. Alkyd and Oil-Base Paints. This category includes most interior compartment and passageway paints, as well as exterior enamel, in accordance with Fed Spec TT-E-490. Personnel mixing these paints shall wear eye protection and gloves during mixing operations. Personal respiratory protective equipment (NIOSH-approved chemical cartridge or air line respirator) shall be required if airborne solvent vapor concentrations cannot be controlled by ventilation. Protective cream, in accordance with Fed Spec P-S-411, Type II (NSN 6580-00-244-4894), may be used on exposed skin to act as a barrier, and for easier cleaning after painting. Skin that comes in contact with these paints shall be promptly cleaned with soap and water (not thinners).

e. Vinyl and Vinyl-Alkyd Paints. These include underwater hull primer Formulas 117 (pretreatment), 119, and 120; antifouling Formulas 121 and 129; and Formula 122 coatings. Personnel mixing these paints shall wear protective garments that fit snugly at the ankles, neck, and wrists; and solvent-resistant snythetic rubber or plastic gloves and apron. NIOSH-approved respiratory protection shall be required when air sampling data indicate solvent concentrations in excess of the exposure limit values, or when it is reasonable to assume that vapor concentrations cannot be controlled by ventilation and are expected to exceed the TLV for the thinner involved.

f. Epoxy Paints. These include paints in accordance with MIL-P-24441. (Formulas 150 through 156), as well as some proprietary paints such as Amercoat, Carboline, Devran, Farbo-Coat, Intergard, Rust-Ban, Sovapon (Mobil), Tarset, and Varni-Lite products which are used for coatings of tanks, bilges, wet spaces, and some exterior surfaces. Personnel mixing epoxy paints shall comply with the precautions given in paragraph above.

g. Because of the ingredients used in epoxy paint, health hazards such as skin inflammation and allergy reactions are greater. If epoxy coatings contact the skin, prompt skin cleanup is mandatory. Soap and water, not solvents, shall be used, as solvents thin the paint and spread it over the skin, thus increasing the hazard of irritation or allergic reaction. Medical attention should be secured if skin reddening or rash appears.

h. Coal Tar Epoxy Paints. Coal tar epoxy paints are recognized as having cancer-causing properties and shall not be used if acceptable alternatives exist. If coal tar epoxy paints must be used, personnel mixing these paints shall wear protective garments which fit snugly at the ankles, neck, and wrists; rubber gloves; chemical worker goggles or fullface respspirator; head covering; canvas boots over their shoes; and an air line respirator. Exposed skin may be covered with a protective cream.

i. Epoxy Thinners and Solvents. Epoxy thinners and solvents used in mixing paints contain ingredients such as ethylene glycol monoethyl that are readily absorbed into the body through the skin. Particular attention to skin protection is necessary to prevent skin absorption from adding significantly to overall exposure, especially during cleaning of equipment.

### 2-10. Health Requirements for Painters.

a. Each command is responsible for ensuring that all painters are included in the installation/activity occupational health medical surveillance program and that they have an appropriate medical evaluation at least annually. This examination shall include all tests specific to the painting profession. Doctor performing examination shall be informed of painters occupation and chemicals to which he is exposed.

b. Showers provided in the shop shall be used by each work shift after spray painting. Also, personnel shall wash hands, arms, and face before eating, drinking, smoking, or using the toilet.

**2-11. Safety Precautions for Paint Application.** Safety precautions for paint mixing apply also to paint application.

a. Danger Area. For each painting operation, the local activity must define and clearly identify, by signs, those areas where there is a possibility that gases or fumes may collect, posing a hazard to the painting personnel and operation.

b. Paint Application. Precautions to be observed when paints are applied by brush, roller, or spray are the same as those for mixing paints; in addition, the potential hazards from flammable or toxic solvents are greater. Additional ventilation in confined spaces is needed. Depending upon location of the painting operation and type of paints being used, respirators and protective clothing may also be needed to comply with personnel protective precautions.

c. Ignition Sources. Steps shall be taken to ensure the absence of ignition sources while paint is being applied. Prohibited activities include welding, smoking, hot work, open flame, and the energizing of electrical circuits (except explosion-proof type) in the same and adjacent compartments and exterior work areas. Areas such as fire, engine, and pump rooms shall be in cold-iron condition before and during paint application.

d. Highly Flammable Paints. Flashpoint labeling is a requirement for all paints and solvents. Personnel shall be instructed to read and understand container labels before using the paint product. Size of posted danger areas, amount of ventilation, and degree of other fire and explosion preventive procedures shall be increased prior to use of low-flashpoing paint materials.

e. Epoxy Paints. Epoxy Paints in accordance with MIL-P-24441, and most interior or tank paints have a flashpoint of about 37.8°C (100°F). Commercial exterior epoxy paints and silicone alkyd surface ship topside enamel (Fed Spec TT-E-490) generally have flashpoints above 26.7°C (80°F). A few paints have lower flashpoints, some below 15.6°C (60°F), and present much greater fire and explosion hazards. These highly flammable paints include vinyl antifouling paints (Formulas 121 and 129), vinyl primers (Formulas 117, 119, and 120), vinly-alkyd paints (Formula 122 series), some special-purpose paints, heat-resistant aluminum paint (Fed Spec TT-P-28), and epoxy primer (MIL-P-23377) for aluminum or corrosion resistant steel (CRES).

f. Vinyl and Epoxy Paints. Personnel applying these paints by brush or roller should avoid skin contact with the paint and its components by wearing solvent resistant, synthetic rubber or plastic gloves, and apron. Sleeves shall be kept rolled down. A face shield or chemical safety goggles shall be worn to protect face and eyes. Fed Spec P-S-411 Type II protective cream (NSN 6850-00-244-4894) may be used on exposed skin to act as a barrier, and for easier cleaning. Local exhaust or supply ventilation, or both, must be used to control personnel exposure to solvent vapors.

**2-12. Application of Paint in Confined Space.** The following precautions shall be observed when painting the interior surfaces of a confined space, such as the inside of a tank.

a. Explosion-Proof Lamps. Explosion-proof lamps with shatter-proof lenses, such as Crouse-Hinds Model RCD-6 or equal, shall be installed. Lights shall be completely and properly assembled and in operable condition prior to installation in the danger area. Bulbs shall not be replaced nor lights repaired within the danger area. Portable lights shall be hung, using sparkproof hooks, and shall never be wrapped around nor draped over supports.

b. Gas-Free Testing. Periodic tests shall be conducted to ensure safe, gas-free working conditions. The gas Free Engineer should conduct the initial test, with monitors conducting the followup tests. During paint operations, gas testing shall continue as necessary to detect dangerous accumulations of hazardous vapor.

c. Ventilation. During painting operations, all tanks and enclosed areas shall be properly ventilated by installing explosion-proof ventilation equipment. If the vented paint vapors will create an explosion hazard outside the tank or compartment being painted, the venting and ventilation shall continue for at least 1 hour after the operation has been completed, and until vapor concentrations remain below 10 percent of the lower explosive limit (LEL).

**2-13. Application By Spray.** The application of paints, varnishes, lacquers, enamels, and other flammable liquids by the spray process is more hazardous than brush application because of the volume of material which can be applied, and because spraying deposits a flammable residue which is subject to spontaneous ignition. Potentially harmful mists created by paint spraying operations add to the health hazard. Precautions for paint spraying include those for mixing and paint application.

a. Fire Prevention Precautions. During spray painting, precautions, in addition to those for brushing or mixing, are necessary to prevent static sparking and excessive flammable solvent concentrations. Danger areas shall extend at least 50 feet from the painting operation, and may include an entire drydock in cases of extensive painting with highly flammable paints. Rope off and post "DANGER AREA" signs in the vicinity of the painting operation to alert personnel to the hazard. These signs must designate the danger area and prohibit smoking, hot work, and open flame. All electrical leads within the danger area shall be sealed and all equipment requiring grounding shall be grounded. During spray painting operations, fire extinguishing equipment shall be in the ready condition.

b. Protective Clothing and Gear. Spray painters shall wear gloves and protective garments that fit snugly at ankles, neck, and wrists. They shall wear filter respirators approved for the operation being performed e.g., spraying, mixing, or handling materials which create flammable vapors. Spray gun mists must never be inhaled.

c. Showers. If paint spraying operations are extensive, showers should be available and operators should shower after every shift.

d. Vinyl and Epoxy Paints. Personnel spray painting with epoxy paints, in accordance with MIL-P-24441, in other than approved spray booths must wear coveralls, gloves, and NIOSH-approved air line respirators which provide full-face coverage. The air supplied to the respirator must be approved for use as breathing air. Approved goggles shall be worn except when eye protection is provided by air-supplied respirators or hoods. Exposed skin areas may be covered with protective cream. The same precautions apply to application of vinyl paints, except that NIOSH-approved organic vapor respirators may be substituted for air line respirators when work is done in open exterior spaces. When these coatings are applied overhead or on surfaces above waist level of the workers, approved hoods which completely protect the head, face, and neck shall be worn.

**2-14. Airless Spray Safety Precautions.** Personnel shall receive complete instructions in the proper use of airless spray equipment before being permitted to operate the equipment or to assist the operators. Training shall stress the potential dangers associated with handling of airless spray equipment, as well as the built-in safety features designed to minimize these dangers. The airless spray method uses a pump to deliver high-pressure fluid to the small, spray-tip orifice. This high-pressure (300 $lb/in^2$) system is potentially hazardous. Amputations and deaths have resulted from careless use of this equipment, particularly when spray tips are removed for cleaning. Before a spray tip is removed or adjusted and when spray operations are shut down for an extended period, it it mandatory that electrical pumps be shut OFF, and that the gun trigger be depressed to bleed line pressure. Painters using airless spray shall comply with the following precautions.

a. Do not use airless spray equipment unless fully trained.

b. Never allow an untrained person to use the equipment.

c. Never put hands or fingers in front of the spray gun.

d. Never point the gun at a person.

e. Never work on or repair pressurized equipment. (The equipment must be shut off, the pressure released, and the trigger safety engaged before disassembly. SHUTTING OFF THE POWER DOES NOT RELEASE THE PRESSURE.)

f. Always secure connections to prevent leaks.

g. Never spray a flammable solvent through the gun tip; the high velocity generates static electricity which could cause a fire or explosion. Unless specifically intended to be operated at other than ground potential, airless spray guns and any conductive object being sprayed shall be properly electrically grounded. This can be done by either using a hose that contains an electrical conductor, or attaching a properly grounded static wire to the spray gun and electrically grounding the object being sprayed.

h. Before use, check hoses for leaks, cuts, and wear. Replace any damaged hose. Never plug hose leaks with fingers.

i. Wear protective gloves and goggles at all times.

j. Use the trigger lock at all times when not actually spray painting (for example, before wiping the tip). Remove the tip guard only if spraying with it in place is impossible.

k. Never leave pressurized airless spray unit unattended.

l. Always remove the gun from the hose after flushing and when storing.

m. The airless spray gun is a dangerous weapon. Keep the trigger safety engaged when not in used.

n. Obtain immediate medical attention for injuries. Report the nature of injury and the type of fluid or solvent being used.

**2-15. Health Hazards and Personnel Exposure Limit Values for Certain Paint Ingredients.** Specific precautions related to hazardous paint ingredients are described in the following paragraphs. Assistance shall be obtained from the Industrial Hygienist or Safety Officer.

a. N-Butyl Alcohol. Exposure to vapors produces irritation of nose, throat, and eyes. The Threshold Limit Value (TLV) is currently set at a ceiling level of 50 ppm (parts per million) by the Committee of the American Conference of Government Industrial Hygienists (AGGIH). Butyl alcohol also causes contact dermatitis. Skin absorption through direct contact with the liquid can add significantly to overall exposure and must be prevented.

b. Cresol. This is strong irritant which frequently causes dermatitis. Serious or even fatal poisoning may result if large areas of the skin are wet with cresol unless it is removed immediately. The TLV (ACGIH) for cresol (all isomers) is 5 ppm. Skin absorption through direct contact with the liquid can add significantly to overall exposure and must be prevented.

c. Dichloromethane. This is volatile solvent, mildly irritating to the skin and eyes. Inhalation of its vapors can produce drunkenness and narcosis. The TLV (ACGIH) for dichloromethane is currently 100 ppm with a Short Term Exposure Limit (STEL) of 500 ppm.

d. Epoxy Resin (Uncured). This is primary skin irritant and possible skin sensitizer. Exposure to epoxy resins in the uncured form shall be minimized. Repeated or prolonged skin contact will dry and defat the skin.

e. Ethylene Glycol Monobutyl Ether. This chemical is moderately toxic if taken orally. It is irritating and injurious to the eyes, but is not significantly irritating to the skin. It is readily absorbed through the skin in toxic amounts and is moderately toxic if inhaled. The current TLV is 25 ppm with a STEL of 75 ppm. It is currently under study for its potential for adverse reproductive effects. The low volatility of ethylene glycol monobutyl ether at room temperature considerably reduces the hazard of toxicity from inhalation. Skin absorption through direct contact with the liquid can add significantly to overall exposure and must be prevented.

f. Ethylene Glycol Monoethyl Ether. This chemical is low in oral toxicity and is not significantly irritating to skin. However, it is readily absorbed through the skin. The current TLV is 5 ppm. It is currently under study for its definite potential for adverse reproductive effects skin absorption, if not prevented, can add significantly to overall exposure.

g. Formic Acid. This acid produces severe primary damage to skin, eyes, and mucous membranes. It is suspected that the presence of formic acid in paint remover could, through destruction of skin tissue, accelerate the absorption of phenol, cresol, and their toxic components. The recommended personnel inhalation TLV (ACGIH) is 5 ppm.

h. Methyl Ethyl Ketone. This chemical can irritate eyes and mucous membranes. Repeated skin contact with the liquid may cause skin dryness and irritation. Exposure to vapor levels above 200 p.m. TLV (ACGIH) may cause narcotic effects.

i. Methyl Isobutyl Ketone. Effects of this chemical are the same as those for methyl ethyl ketone, except that the TLV (ACGIH) is 50 ppm with a STEL of 75 ppm.

j. Methyl Normal Butyl Ketone. Effects of this chemical are the same as those of methyl ethyl ketone, except that it can also cause nervous system damage. Its TLV (ACGIH) is 25 p/m. An industrial hygienist, or NRMC Occupational Health Service, shall be consulted before using methyl normal butyl ketone.

k. Paint Thinner, Fed Spec TT-T-291, Type II, Grade A, Boiling Range 150°C - 210°C (302°F - 410°F). Paint thinner vapors are mildly irritating to mucous membranes. Repeated or prolonged skin contact with paint thinner will dry and defat the skin, resulting in irritation and dermatitis. The personnel TLV (ACGIH) for Stoddard Solvent, which is comparable to Type II, Grade A, is 100 p/m.

l. Phenol. This hazardous chemical is highly toxic when ingested, inhaled, or absorbed through the skin. It is really absorbed through intact skin. Death has been reported to result from absorption of phenol through a skin area as small as 64 square inches. Death from acute exposure to phenol may occur within 30 minutes. The current TLV is 5 ppm.

m. Polyamide. Polyamide has mild skin irritant and skin sensitizing properties.

n. Super High-Flash Naphtha, Boiling Range 157°C - 179°C-(315°F -353°F) This chemical contains up to 98 percent aromatic hydrocarbons. Some of the aromatics in high-flash naphtha (for example, mesitylene) are highly toxic by inhalation. However, the fairly low vapor pressure of these components reduces the inhalation hazard when the solvent is used in ventilated areas. Inhalation of the concentrated vapors can cause headache, nausea, and coma.

o. Lead Chromate and Zinc Chromate. These chromates are classified as suspected carcinogens by ACGIH and shall be handled and used accordingly. Whenever possible, materials of lesser toxicity should be substituted. Overexposure to chromates may result in nasal septum ulceration and respiratory tract irritation. The TLV has been set at 0.05 mg/m$^3$ (milligrams per cubic meter of air).

**WARNING**

Organotin - Antifouling Paints are not authorized for Army use.

**2-16. Organotin Antifouling Paints.** Antifouling paints that contain organotin compounds are highly toxic to the skin, eyes, and respiratory tract by either direct contact with the paint or coated surfaces or, by exposure to vapors or mists. Eye and respiratory irritations usually occur immediately upon exposure. Skin irritation normally occurs within 24 hours of exposure. Harmful exposures have also resulted from welding and burning operations; contact with wet paint, paint mist, or dried paint overspray; and contact with contaminated sandblasting dust. Any operations involving welding, burning, grinding, sanding, or otherwise heating the dried coating will release toxic and irritating dust or vapors. During the use of these materials, stringent controls are required to prevent or minimize personnel injuries.

a. List of Organotin Antifouling Paints. Organotin antifouling paints are identified as follows:

(1) Amercoat 1795

(2) Andrew Brown Colortox

(3) Biomet 410

(4) Devoe XM-075

(5) Devran MD-3198

(6) DTNSRDC Organometallic Polymer (OMP)

(7) Glidden Vinyl-Cote No-Copp

(8) Internal Self-Polishing Copolymer (SPC)

(9) International Tri-Lux

(10) International Wide Spectrum

(11) M. I. Formula 1011

(12) M. I. Formula 1020A

(13) M. I. Formula 1028

(14) Navy Formulas 170, 171, 172, and 173

(15) Rust-Ban VY-5529

(16) Tarset 305.

b. List or Organotin Antifouling Rubbers. Organotin antifouling rubbers are identified as follows:

(1) NOFOUL (B.F. GOodrich)

(2) ANTIFOULANT RUGGER (Goodyear Aerospace).

(3) Product 1195 and 305 (Porter Paint Co.)

**2-17. Safety Precuations and Requiremernts for Abrasive Blasting.** The safety precautions and requirements that shall be taken to prevent introduction of abrasive-blasting materials into ship spaces and unprotected equipment, and to prevent injury and property damage, are described below. These precautions apply to all abrasive blasting operations on and within the vicinity of all US Army watercraft.

a. Preoperational Requirements. Abrasive blasting shall not be undertaken until positive steps have been taken to prevent contamination and spread of abrasives and dust to adjacent compartments, machinery, and equipment. Abrasives and dust can enter ships through open sea valves, hatches, ventilation systems, temporary openings, normal entryways frequently opened and closed, and entryways which must remain open to accommodate other work. If there is any possibility that abrasives can enter a ship or ship's compartment in spite of all possible precautions, critical machinery surfaces and parts, and electric and electronic equipment, shall be positively sealed or otherswise protected. Machinery components, such as reduction gears, open boilers, hotwells, and turbines in various stages of disassembly, are especially subject to damage from contamination.

(1) Prior to blasting operations, the responsible shop shall notify the ship force, and all other ships in the vicinity, of time and location of proposed abrasive blasting operations. All shops and the ship force shall take the following precautions to protect equipment and structures:

(a) Drop cloths and masking shall be used to prevent damage from the abrasive material.

(b) Temporary shields and other sealing or closing-off measures shall be used to prevent abrasives from entering machinery, pipes, seawater inlets, and pump wells through various openings.

(c) Where remote service connections provide water or ventilation, such as seawater from the auxiliary seawater system while the ship is in drydock, the inlet to that connection shall be positioned and measures taken to prevent the entry of blasting contaminants.

(d) Additional precautions shall be taken to the extent necessary to protect adjacent ships, buildings, and stores.

(2) Personnel in or near the blasting area shall be warned of blasting operations. In all circumstances, close cooperation between ship and shipyard personnel is required.

(3) The entire area to be blasted shall be visually inspected. Heavily rusted or corroded areas, damaged metal, and holes in the structure or piping shall be checked to determine if technical examination is warranted, and for possible repair prior to blasting. Abrasive blasting hoses routed through compartments shall be identified by an appropriately marked sign posted in each compartment, warning against damaging the hoses.

b. Postoperational Requirements. After any blasting or contamination of ship interior, the equipment or components blasted or contaminated by abrasive dust shall be cleaned and tested prior to being put into service. The entire area shall be visually inspected for pits, scabs, and scars. Suspected wall thickness reductions shall be reported for further technical examination.

c. Blasting Unit Operational and Maintenance Safety Precautions. Each abrasive-blasting hose and its control line shall be color-coded at both ends to avoid cross-connecting hoses or lines. Hoses shall be equipped with deadman controls, audio-visual signaling devices, and manually operated air supply choke valves. The deadman control shall be the type that requires continuous pressure by the blast operator, and secures the air pressure to the nozzle automatically in the event the nozzle becomes unattended. The high-pressure air supply choke valve shall be kept closed by the machine operator or pot tender at all times except during actual blasting. Operational and maintenance procedures and safety precautions shall be developed and posted on each blasting unit and shall include the following requirements.

(1) Hoses and nozzles have been inspected and are in satisfactory operating condition.

(2) Color codes on both ends of each blasting hose match those on the control lines for that hose.

(3) Deadman controls are attached to the hoses prior to positioning aboard ship.

(4) Deadman control, horn, and light operate correctly prior to positioning aboard ship.

(5) Blast operators shall not circumvent the deadman control by tying down the deadman lever.

(6) Choke valve is closed until the blast operator signals readiness to commence blasting.

(7) Blast operators shall not overblast, pit, or scar the surface being blasted.

(8) Noise hazard areas are posted.

d. Audio-Visual Operating Signals. The supervisor shall review audio-visual signals, operational procedures, and safety precautions weekly with all personnel directly involved in blasting operations. A signal horn (or buzzer) and a light mounted on the machine shall be used to establish positive communication from each blast operator to the machine operator or pot tender where there is no visual contact. Hand signals may be used when there is visual contact. Audio and visual signals shall be standardized and posted on each blasting unit, including signals for close choke valve, open choke valve, more abrasive, and emergency.

e. Protective Equipment. All blast operators shall wear hoods and air line respirators or air helmets of the positive-pressure type. Other mandatory clothing includes rubber or leather gauntlet gloves, safety shoes, and coveralls. The blast operator shall wear a safety belt or harness when working on staging or other elevated places. Personnel other than blast operators, including machine operators and personnel engaged in work in the vicinity of abrasive blasting operations, shall wear full eye protection and NIOSH-approved dust respirators. Approved ear protectors shall be worn wherever the airborne noise level is above 85dBA. Both earplugs and ear muffs (double protection) shall be worn if the noise level exceeds 108 dBA.

f. Staging shall be stable and correctly positioned for the safety, convenience, and comfort of the blast operator.

g. Operating Safety Precautions. The nozzle shall never be pointed in the direction or ricochet line of another person, even with the air and abrasive stream shut off. The blast operator shall always keep hands and other parts of the body away from the discharge and the nozzle, and shall never try to adjust the nozzle while the abrasive stream is flowing.

h. Hoses shall be secured, leaving only enough free length to be handled safely by the blast operator. All hoses, fittings, and so forth shall be inspected before blasting begins; worn parts shall be discarded. When couplings are located where sudden parting would be hazardous, both coupled hoses shall be secured to a strong support or to each other.

i. Abrasive-blasting equipment shall be properly maintained because operation of damaged or poorly maintained equipment at high pressures is dangerous.

j. Whenever practical, hoppers and hopper tenders should be located on top of drydock walls rather than in the basin. This improves housekeeping and permits grit flow to be aided by gravity. Minimizing the number of people who must be in the dock basin reduces the risk of injury if a hose or connection should break, causing the hoses to whip.

**2-18. Abrasive Blasting Limitations for Steam Plants.** Abrasive blast cleaning of installed (onboard) steam plant components is prohibited. Blast cleaning of installed tanks is allowed, provided the following listed conditions are met, in addition to the other requirements of this section.

a. All piping ends and other tank openings shall be plugged to preclude spread of blasting materials.

b. All internal tank parts must be accessible for hand cleaning (to ensure removal of all blasting material prior to plug removal).

c. When large hull tanks are blasted, sealing the blast operator in the tank may be a practical way, if space permits, to preclude contamination or damage to other equipment or components. When this appears practicable, advance National Maintenance Point (NMP) approval shall be obtained for proposed procedural details, including safety precautions. If this is not practicable, equipment and components must be protected by methods such as those specified in paragraph 2-16. Safety Precautions and Requirements for Abrasive Blasting.

**2-19. Safety Precautions for Hydroblasting.** Although not considered to be as hazardous as abrasive blasting, hydroblasting uses water at high pressure which can cut through the body, causing serious injury or death. The abrasive blasting precautions (paragraphs 2-16.a. and 2-16.b), the protective personnel equipment (paragraph 2-16.c.), and the special precautions given in the following paragraphs, shall apply when abrasives are injected into the water stream.

a. Visual Operating Signals. Prearranged visual signals shall include: Start, Stop, Increase Pressure, Decrease Pressure (for the pump), Shut Down Engine, and Bleed Pressure.

b. Pump Operator. One person shall be stationed at the pump at all times to monitor running condition, control reserve water level, make pressure adjustments, handle emergencies (such as a ruptured hose), perform emergency procedures (stop engine, bleed pressure), and clear hoses at ground or pump location. The pump operator shall maintain visual contact with the gun operator and his assistant, and respond immediately to their signals. Pump operators exposed to noise levels ablve 85 dBA shall wear approved earplugs or ear muffs. If the noise level exceeds 108 dBA, then both earplugs and ear muffs (double protection) shall be worn.

c. Gun Operator. Two workers shall be assigned to each gun being operated and shall relieve each other as required. The assistant shall keep hoses clear of all obstructions, assist the operator as required by supporting the hose weight, be alert to potential hazards which may be encountered by the operator, and take corrective action as required. The assistant shall also observe work done by the operator, point out missed areas, and provide visual signals to the pump operator as necessary. The gun operator and assistant shall wear wet-weather gear, face shield or goggles, work gloves, shoes with antiskid soles, and when working from a scaffold or other elevated position, a safety harness.

d. Equipment and Operating Precautions. Hydroblast equipment must be properly maintained because operation of damaged equipment at high pressure is dangerous. Staging shall be stable and correctly positioned so that the worker can hold the gun at a 60° angle with top approximately 8 to 12 inches from the surface being blasted.

(1) The hydroblast gun shall never be pointed at other personnel. The water stream is capable of severing an arm or leg.

(2) The straight jet nozzle shall be used only in special cases such as cleaning weld seams or crevices. Caution must be used because the water stream will rapidly cut through paint to bare metal.

**2-20. Safety Precautions for Electrically Operated Power Tools.** Portable power tools shall be equipped (by manufacturer or modification) with a safety throttle/lock-off device or a protected throttle switch to prevent inadvertent startup caused by tools being dropped, bumped, or stepped on. Precautions for power tools are described below.

a. Inspection. Portable power tools shall be kept cleaned, oiled, and repaired. Tools shall be carefully inspected before use; switches must operate, cords shall be clean and free from defects, and plugs shall be clean and sound. The switch on a tool shall be in the OFF position at the time the tool is plugged into a receptacle. Tools shall be stored in a clean, dry place.

b. Grounds. Metal-cased portable tools shall be fitted with three-pronged plugs. Portable tools with double-insulated plastic cases are designed to be electrically safe without the use of a three-pronged plug. A two-conductor flexible cable and a two-pronged plug suitable for use with grounded type receptacles may be used for all such equipment. Double-insulated tools with metal gearings, and housings with two-pronged converter are also acceptable.

c. Fire Hazards. Portable electric tools with brushes (sparking) shall not be used where flammable vapors, gases, liquids, or explosives are present.

d. Cord Care. Cords should not be allowed to kink, nor be left where they might be run over. Cords must not come in contact with sharp edges, hot surfaces, oil, grease, water, or chemicals. Damaged cords shall be replaced, not repaired. Patching cords with tape is prohibited. Tools shall be stored with cords loosely coiled.

e. Extension Cords. Only three-wire extension cords with three-pronged plugs and three-slot receptacles shall be used. Because a metal hull ship is a hazardous location, personnel using a portable electric device connected to extension cords shall plug the device into the extension cord before the extension cord is inserted into a live bulkhead receptacle. Likewise, the extension cord shall be unplugged from the bulkhead receptacle before the device is unplugged from the extension cord.

## 2-21. Safety Precautions for Pneumatic Tools.

a. Personnel. Only authorized and trained personnel shall operate pneumatic tools. Operators using pneumatic tools shall wear and use necessary protective devices, including hearing protection. Personnel with arthritis, neuritis, or circulatory disease shall be examined by a Medical Officer to determine if their medical condition might be aggravated if they were to operate vibrating tools such as pneumatic hammers, chisels, tampers, riveters, or corkers.

b. Inspection. Pneumatic tools shall be thoroughly inspected at regular intervals. These tools shall be kept in good operating condition, and particular attention should be given to valves, hose connections, guide clips on hammers, and chucks of reamers and drills during the inspection. All pneumatic tools should be labeled as hazardous noise sources.

c. Disconnection. Pressure shall be shut off and bled from the line before a pneumatic tool is disconnected. The tools shall be fitted with a quick-disconnect fitting and, when the tool is not in use, it shall be disconnected from its supply hose.

d. Air Hose. The air hose shall be rated for the pressure required for the tool. Leaking or defective hoses shall be removed from service. Hoses shall be laid to avoid creating a tripping hazard, particularly on ladders, steps, scaffolds, and walkways. Hoses that are run through doorways shall be protected against damage caused by the door edge. An air hose shall never be pointed at any person.

e. Compressed Air. Compressed air shall not be used to clean clothing being worn, nor shall it be used to blow dust off the body. Compressed air shall never be used as a power source for a projectile or to clean the deck or space where the pneumatic tool was used.

## 2-22. Safety Lock-Off Devices.

a. Definition. A safety lock-off device is any operating control which requires positive action by the operator before the tool can be turned on. The lock-off device shall automatically and positively lock the throttle in the OFF position when the throttle is released. Two consecutive operations by the same hand shall be required, first to disengage the lock-off device and then to turn on the throttle. The lock-off device shall be integral with the tool, shall not adversely affect the safety or operating characteristics of the tool, and shall not be easily removable. Devices such as a deadman control or quick-disconnect, which do not automatically and positively lock the throttle in the OFF position when the throttle is released, are not safety lock-off devices.

b. Action. Shore activities shall establish a program to replace the existing inventory of portable pneumatic grinders and reciprocating saws with grinders and saws equipped with safety lock-off devices. This conversion shall be accomplished by purchasing such tools equipped with safety lock-off devices to replace existing grinters and saws as they are retired, except as prescribed below.

(1) Initiate immediate procurement to obtain a supply of new grinders and saws with safety lock-off devices to be used on high-value work where inadvertent tool activation could cause significant material damage.

(2) Issue directives which specify that only portable pneumatic grinders and reciprocating saws equipped with safety lock-off devices shall be used on high-value work.

(3) Prohibit purchase of portable pneumatic grinders and reciprocating saws lacking safety lock-off devices.

**2-23. Safety Precautions for Solvent and Chemical Cleaning.** These safety precautions apply to chemicals used to clean painted areas. Paint removers or strippers have additional special precautions which are listed below and in paragraph 2-24.

a. Solvent Cleaning. Personnel protection, fire prevention, and ventilation requirements for solvent cleaning are the same as those specified for mixing and applying paint in paragraphs 2-7 and 2-11.

b. Chemical Cleaning. A method for cleaning ferrous metal surfaces of surface ship bilges is approved for use only on surface ships at shipyards and shall not be used at locations other than shipyards. This method shall not be used on or near aluminum.

c. Chemical Cleaning Materials. Chemical cleaning materials include sodium hydroxide (lye), sodium gluconate, and detergent. Alkaline powders and solutions constitute an extreme personnel hazard if improperly handled. Concentrating or heating solutions is ordinarily prohibited because it compounds the danger. These solutions may permanently damage or burn the eyes, severely burn skin and damage tissue, and cause death or severe injury if swallowed. Mists and dusts may severely irritate the eyes, nose, and throat.

d. Caustic Solutions. Caustic solutions shall not be prepared or stored in wide-open steel tanks. The tanks used for storage shall have a small tank opening and shall be closed during storage. Caustic solutions shall be transferred through alkali-resistant pumps and lines. Entry into bilges containing caustic solutions is prohibited. If entry is imperative, the caustic solution shall first be removed.

e. Personnel Safety Precautions. Personnel shall be thoroughly instructed regarding the hazards of using chemical cleaning materials. Personnel working in areas where chemical solutions are being used, prepared, or transferred shall be dressed in clothing impervious to the chemicals. This includes splash goggles or face shields. Treadle-actuated, whole-body showers and eyewashes shall be provided near work areas where caustic solutions are prepared, used, or stored.

**2-24. Safety Precautions for Paint Strippers and Removers.** Paint strippers and removers present one or more of the following hazards: fire, anaesthetic, toxic, or caustic. Accident investigation results indicate that extreme handling precautions are required because of these hazards and the number of different formulations involved.

a. Paint Strippers and Removers. Paint strippers containing phenol or cresol are considerably more toxic than most shipboard paints or solvents. Both phenol and cresol are readily absorbed through the skin and may cause serious illness, or even death, if not washed off promptly. In the case of phenol-containing paint removers (for example, those in accordance with MIL-R-46116, MIL-R-81924, and MIL-R-81903), personnel protection includes, as a minimum, solvent-resistant synthetic rubber gloves and boots, solvent-resistant suits or coveralls, and rubber-framed goggles and face shields. Full eye protection with respirators or air-supplies hoods is mandatory whenever the atmospheric limits for the air contaminants are exceeded. Personnel not essential to the paint stripping operation should be evacuated.

b. Accidental Contact. Clothing wetted with the paint remover shall be removed immediately and not rework until laundered. If paint remover contacts the skin, flush off immediately with large quantities of water. If remover enters the eyes, flush with running water for at least 15 minutes with the eyelids held open. Medical attention must be obtained. Personnel using these paint removers must have ready access to a safety shower and eyewash fountain.

c. Prohibited Use. Paint strippers or removers shall not be used on fiberglass-reinforced plastic laminates, other plastics, electrical insulators (other than ceramic), or other materials which may be damaged by the stripper. Caustic strippers shall not be used on aluminum, magnesium, or zinc.

d. Personnel Protective Procedures. Paint strippers or removers shall not be used until personnel protective guidance for the specific proposed use has been obtained from an Occupational Health Service. Other paint removal methods shall be used (paragraphs 2-17 through 2-23 for applicable precautions) if personnel protective guidance cannot be practicably implemented.

# SECTION 3 SURFACE PREPARATION

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**3-1. General.** The best quality paint will perform effectively only if applied to a surface which has been properly prepared. The initial cost of adequate surface preparation is justified because of the increase in durability, and the achievement of the maximum coating life with minimum repairs and repainting.

**3-2. Surface Preparation.** The responsible activity's judgment shall prevail in selecting the surface preparation method, except when an official document specifies a particular method. Selection of surface preparation methods shall be based on:

a. Nature of substrate.

b. Existing condition of surface to be painted.

c. Type of exposure.

d. Past history of the surface to be preserved.

e. Practical limitations such as time, location, space, and equipment availability.

f. Economic considerations.

g. Type of paint to be applied.

h. Safety factors.

**3-3. Painted Surfaces.** Preparation of painted surfaces includes the removal of surface contaminants, corrosion, old paint, moisture, blending (touchup paint), and roughening the surface (old paint in good condition).

**WARNING**

**Most surface preparation methods generate noise levels in excess of 85 dB.**

Personnel working on surface preparation shall wear approved hearing protective devices and shall be given periodic audiometric examinations. All noise hazard areas shall be posted with appropriate warning signs.

**3-4. Removing Surface Contaminants.** Surface contaminants must be removed to ensure coating adhesion and minimize the possibility of defects such as blistering, peeling, flaking, and underfilm rusting. Surfaces to be painted for preservation must be completely free of mill scale, rust, loose paint, dirt, oil, grease, salt deposits, and moisture. To prevent embedding contaminants during surface preparation, oil or grease must be removed before using power tool or abrasive-blast surface preparation. Rusted surfaces shall be freshwater rinsed, where practicable, to remove water soluble contaminants before abrasive blasting or additional surface prepration by other means. Weld spatters and flux compounds should be removed by grinding or chipping.

a. Removing Old Paints. In touchup painting for preservation, when only localized areas or spots need attention, removal of old paint must go beyond the visibly defective areas until an area of completely intact and adhering paint film is attained, with no rust or blisters underneath. The edges of tightly adherent old paint remaining around the area must be tapered (feathered) to allow proper blending and prevent laying new paint over loose or cracked paint. When painted surfaces show evidence of corrosion, peeling, blistering checking, scaling, or general disintegration, the paint is to be removed down to the bare surfaces.

b. Preparing Old Paint in Good Condition. Old paint in good condition provides an excellent base for repainting. When a surface is to be repainted and the old paint is not to be removed, the surface shall be roughened with an abrasive and cleaned and dried before new paint is applied. Roughening may be omitted when hydroblasting of underwater hull areas results in clean vinyl antifouling paint showing the original red or black color. Roughening may also be omitted where painting is being done for appearance, rather than preservation, and some peeling or flaking can be tolerated.

c. Preparing Damp Exterior Surfaces. When painting over damp exterior surfaces cannot be avoided, preservation can be improved if the moisture is removed by wiping surfaces dry with methyl isobutyl ketone, paint thinner, or ethylene glycol monoethyl (EGM) ether prior to painting. Blowing surfaces dry with compressed air can hasten evaporation of the solvent or water. In addition, it is preferable for the first coat of paint to be brushed on.

**3-5. Metallic Surfaces.** Blast-cleaning is the most effective and the preferred method of preparing metallic surfaces for painting. If abrasive blasting is not specified or permitted, mechanical means shall be used. If the surface to be painted is subject to flash rusting, blast-clean only the area that can be coated with paint immediately, before flash rusting can occur.

a. Steel Surfaces. When blasting to bare steel is specified or required, surfaces shall be cleaned to near-white condition, as prescribed in para. 3-19.a. Near White Metal Blast.

b. Aluminum Surfaces. Aluminum surfaces shall be cleaned free of corrosion products, dirt, and other contaminants by light abrasive blasting. Use of 80-grit aluminum oxide or garnet abrasive at 65 lb/in$^2$ pressure has resulted in satisfactory aluminum surface preparation, with minimum metal removal.

**NOTE**

**The abrasive sanding discs used on aluminum must not have been used previously on other metals or to remove copper or mercury pigmented paints.**

c. Spot Cleaning. Spot cleaning after blasting can be done by power brushing or orbital sanding. For cleaning aluminum, only clean dry sand, stainless steel wire brushes, stainless steel pads, or abrasive sanding discs (Fed Spec P-D-455). If the cleaned aluminum surface is not painted immediately or becomes contaminated with oil or grease, the surface shall be washed with a liquid detergent cleaner (MIL-C-18687, Type II), rinsed with fresh water, and allowed to become completely dry before paint is applied.

**3-6. Wood Surfaces.** Before wood surfaces are prepared for painting, ensure that all required structural repairs have been completed. All dents, holes, and cracks must be filled with putty. Surfaces should be sanded or planed smooth. Use of double planking cement, in accordance with MIL-S-19653, is required on frame ends and stern head and between all faying surfaces where watertight integrity is mandatory. Aluminum paint shall not be used where watertight integrity is required.

**3-7. Wood Preservation.**

a. Preservation. After the wood has been shaped, bored, and cut, it shall be soaked, except where varnish is specified, for 10 minutes in wood preservative (MIL-W-18142, Type A or B). For wood requiring varnish, only those surfaces adjacent to moldings, coamings, and in locations subject to dampness and decay need be treated. Lumber where varnish is specified shall be treated only with Type B preservative to which no coloring ingredients have been added. If fairing, boring, or trimming is necessary after preservative treatment, the reworked surfaces shall be submerged for 15 minutes in, or liberally brushed with, the preservative used originally. Retreatment of the outer hull is required after sanding only adjacent to guards. Treated lumber must dry a minimum of 72 hours before it is painted, calked, or glued.

b. Surface Preparation. Wire brushing, scraping, solvent cleaning, milling of surface, application of paint and varnish removers, or a combination of these techniques are commonly used methods to prepare a wood surface for repainting. Abrasive blasting has also been used successfully for preparing wood surfaces.

**3-8. Plastic Surfaces.** Plastic surfaces requiring painting shall be lightly roughened. All extraneous matter shall be removed by washing with detergent, rinsing, wiping with a solvent, or by other suitable means. Glazed surfaces shall be sanded to promote adhesion.

**3-9. Surface Cleaning Methods.** The goal of surface cleaning is to provide a roughened surface which is free of contamination and gouges or sharp projections. Roughening is necessary to attain the necessary anchor pattern for good paint adhesion. Surface cleaning methods vary with the type of surface preparation needed, location, and size of the area being cleaned.

**3-10. Hand Cleaning.** Hand cleaning will remove only loose or loosely adhering surface contaminants, including rust scale, loose mill scale, loose rust, and loosely adhering paint. Hand cleaning is not to be considered an appropriate procedure for removing tight mill scale and all traces of rust; it is primarily recommended for spot cleaning in areas where corrosion is not a serious factor.

**CAUTION**

**Removal of contaminants by hand cleaning must be done carefully to avoid deep tool marks or gouges on the surface.**

a. Before hand cleaning, the surface must be free of oil, grease, dirt, chemicals, and water soluble contaminants, all of which can be removed with solvent cleaners and freshwater rinsing. Impact tools, such as chipping hammers, chisels, and scalers shall be used to remove rust scale and any heavy buildup of old coatings. Use vacuum or other removal methods to clean the area of dust and debris. Start painting as soon as possible after cleaning.

b. In those situations where areas are not accessible to power tools, hand-cleaning methods may have to be used. Since hand cleaning will remove only the loosest contamination, careful application of primers is required, preferably by brushing, to thoroughly wet the surface. To achieve satisfactory results, all applied coats must be capable of overcoming the interference of contaminants left behind after hand cleaning.

### 3-11. Power Tool Cleaning

a. Cleaning. Power tool cleaning methods will prepare surfaces faster and better than handtool methods. Power tools are used for removing small amounts of tightly adhering contaminants that handtools cannot remove; but compared with blasting, they are uneconomical and time consuming for removal of tight mill scale, rust, or old coatings from large areas. Power tools are driven either electrically or pneumatically and the basic units include a variety of attachments. Before power tool cleaning, the surface must be free of oil, grease, dirt, chemicals, and water soluble contaminants, all of which can be removed with solvent cleaners and fresh water rinsing. If oily residue is detected after power tool cleaning, solvent cleaning should be repeated. Painting must be started and completed as soon as possible after power cleaning.

b. Types of Power Tools. Chipping hammers are used to remove tight rust, mill scale, and old paint from large metallic and masonry areas. Wire brushes (cup or radial) are used to remove loose mill scale, old paint, weld flux, slag, and dirt deposits. Grinders and sanders are used to smooth excessively rough surfaces. As with handtools, care must be exercised with power impact and grinding tools so they do not cut too deeply into the surface, resulting in burrs that are difficult to cover and protect satisfactorily. Care must be taken when using wire brushes to avoid polishing metal surfaces, which would prevent adequate adhesion of subsequent coatings.

**3-12. Safety Precautions and Requirements for Power Tool Cleaning.** Goggles, faceshields, or similar protection against flying particles should be worn. Also, gloves, aprons and leggings may be advisable if there is a problem with hot sparks. Respiratory protection filtermasks should be provided for prolonged exposure. These tools should not be used in the vicinity of readily ignitible materials or within 50 feet of volatile flammable liquids, such as those used in cleaning and painting. Also, operations should not be conducted where there is the possibility of the presence of combustible gases.

**3-13. Abrasive Blasting.** Abrasive blasting is the preferred method for preparing metal surfaces. Blast cleaning abrades and cleans through high-velocity impact on the surface of sand, metal shot, metal and synthetic grit, or other abrasive particles. The abrasive is discharged, either wet or dry, under presssure. The wet system differs from the dry in that a solution of water and rust inhibitor is incorporated with the blast abrasive. The rust-inhibiting solution is either mixed with the abrasive in the pressure tank or is introduced into the blast stream just behind, or just in front, of the blast nozzle. All blasted metal surfaces require that prime painting be started and completed the same day to prevent new rust from forming. Blast-cleaned surfaces are subject to rapid rusting if not coated.

**3-14. Safety Precautions and Requirements for Abrasive Blasting.** The safety precautions and requirements that shall be taken to prevent introduction of abrasive-blasting materials into ship spaces and unprotected equipment, and to prevent injury and property damage, are described in paragraphs 2-16.a. through 2-16.c. These precautions apply to all abrasive blasting operations on and within the vicinity of all US Army Watercraft.

a. Preoperational Requirements. Abrasive blasting shall not be undertaken until positive steps have been taken to prevent contamination and spread of abrasives and dust to adjacent compartments, machinery, and equipment. Abrasives and dust can enter ships through open sea valves, hatches, ventilation systems, temporary openings, normal entryways frequently opened and closed, and entryways which must remain open to accommodate other work. If there is any possibility that abrasives can enter a ship or ship's compartment in spite of all possible precautions, critical machinery surfaces and parts, and electric and electronic equipment, shall be positively sealed or otherwise protected. Machinery components, such as reduction gears, open boilers, hotwells, and turbines in various stages of disassembly are especially subject to damage from contamination.

(1) Prior to blasting operations, the responsible shop shall notify all other ships in the vicinity, of time and location of proposed abrasive blasting operations. All shops and the ship force shall take the following precautions to protect equipment and structures:

(a) Drop cloths and masking shall be used to prevent damage from the abrasive material.

(b) Temporary shields and other sealing or closing-off measures shall be used to prevent abrasives from entering machinery, pipes, seawater inlets, and pump wells through various openings.

(c) Where remote service connections provide water or ventilation, such as seawater from the auxiliary seawater system while the ship is in drydock, the inlet to that connection shall be positioned and measures taken to prevent the entry of blasting contaminations.

(d) Additional precautions shall be taken to the extent necessary to protect adjacent ships, buildings, and stores.

(2) Personnel in or near the blasting area shall be warned of blasting operations. In all circumstances, close cooperation between ship and shipyard personnel is required.

(3) The entire area to be blasted shall be visually inspected. Heavily rusted or corroded areas, damaged metal, and holes in the structure or piping shall be checked to determine if technical examination is warranted, and for possible repair prior to blasting.

b. Protective Equipment. All blast operators shall wear hoods and air line respirators or air helmets of the positive-pressure type. Other mandatory clothing includes rubber or leather gauntlet gloves, safety shoes, and coveralls. The blast operator shall wear a safety belt or harness when working on staging or other elevated places. Staging shall be stable and correctly positioned for the safety, convenience, and comfort of the blast operator. Personnel other than blast operators, including machine operators and personnel engaged in work in the vicinity of abrasive blasting operations, shall wear full eye protection and NIOSH-approved dust respirators. Approved ear protection shall be worn wherever the airborne noise level is above 85 dBA. Both earplugs and ear muffs (double protection) shall be work if the noise level exceeds 108 dBA.

c. Operating Safety Precautions. The nozzle shall never be pointed in the direction or ricochet line of another person, even with the air and abrasive stream shut off. The blast operator shall always keep hands and other parts of the body away from the discharge and the nozzle, and shall never try to adjust the nozzle while the abrasive stream is flowing.

(1) Hoses will be secured, leaving only enough free length to be handled safely by the blast operator. All hoses, fittings, and so forth shall be inspected before blasting begins; worn parts shall be discarded. When couplings are located

where sudden parting would be hazardous, both coupled hoses shall be secured to a strong support or to each other.

(2) Abrasive-blasting equipment shall be properly maintained because operation of damaged or poorly maintained equipment at high pressures is dangerous.

(3) Whenever practical, hoppers and hopper tenders should be located on top of drydock walls rather than in the basin. This improves housekeeping and permits grit flow to be aided by gravity. Minimizing the number of people who must be in the dock basin reduces the risk of injury if a hose or connection should break, causing the hoses to whip.

**3-15. Abrasive Materials.** Metal or synthetic shot, grit, or similar abrasives are used where recovery of the abrasive is possible. Sand or other low-cost materials is used when the abrasive agent is expendable, but the use of sand is costly. The abrasive grit must be of a size sufficient to remove surface contamination without working the surface to excess. Overworking creates extreme peaks and valleys on the surface which require an additional buildup of the applied paint film for adequate protection. The peaks, if too high, represent possible areas of premature failure in coating systems with less than 5 mils dry film thickness.

**3-16. Abrasive Material Procurement.** Procurement of blasting abrasive shall be in accordance with MIL-S-22262 (SHIPS), Class 2. Depending upon local needs, any or all of the following additional requirements shall be considered:

a. A certified chemical analysis of the abrasive material shall state the amount of arsenic, beryllium, cadmium, chromium, fluorine, lead, mercury, radioactive materials, and free silica contained in the material.

b. The gross gamma radio-activity concentration of abrasive blasting materials shall not exceed 5.0 picocuries ($5.0 \times 10^{-12}$curies) per gram.

c. MIL-S-22262 shall be interpreted to include the meaning that the abrasive material shall not contain more than 1 percent by weight of any toxic substance.

**3-17. Dry Blasting.** The two dry blasting methods of surface cleaning are described below.

a. Conventional Blasting. Conventional blast cleaning is a term used to designate the usual method of field blasting, in which no effort is made to alleviate the dust hazard nor recycle the blasting abrasive. Conventional blasting does not require special rinsing, as is required for wet blasting, but it does require that health precautions be taken to protect the operator and other personnel in the area from the fine, abrasive dust. Machinery in the vicinity must also be shielded from the dust. After blasting, the surface must be brushed, vacuumed, or air cleaned to remove residues or trapped grit.

b. Vacuum Blasting. Vacuum blasting is a surface cleaning method which minimizes the dust hazard and reclaims the blast abrasive. Vacuum blasting allows practically no dust to escape to contaminate the atmosphere. On highly irregular surfaces, the vacuum method of blasting is less efficient than conventional blasting methods because of the poor vacuum on such surfaces. When the blasting cone is held firmly against the surface to prevent abrasive loss and the surface is heavily contaminated with rust, algae, or other foreign matter, the machine may become clogged after operating only a short time. When clogging occurs, the vacuum blaster is used as a semiopen blasting device and the cone containing the nozzle is held at a slight distance away from the surface. A considerable amount of dust is created (workers must wear respirators), but not as much as that created by conventional blasting. Vacuum blasting is efficient and economical for cleaning repetitive, small-scale surfaces in a shop. The process results in considerable savings in abrasive costs and also reduces the dust and the health hazard.

**3-18. Wet Blasting.** Wet blasting reduces the dust associated with blasting to a minimum, but is not suitable for certain types of work as described below.

a. Wet Blasting Disadvantages. When blasting is used on steel structures having many ledges formed by upturned angles or on horizontal girders, a considerable amount of cleanup work is required. Wet sand and other blast residue trapped on these ledges are more difficult to remove than dry materials. Some sludge will adhere to wet-blasted surfaces, requiring removal by rinsing, brushing or compressed air. The blasted surface shall be thoroughly dry before coatings are applied.

**WARNING**

**On standing, the rust-inhibiting solution decomposes to form gases. Stock solutions of the inhibitor must not be used.**

b. Rust Inhibitor. When wet blasting, a rust inhibitor is used in the blasting unit, followed by a rust-inhibiting wash. For galvanized surfaces, the rust inhibitor is omitted. The rust inhibitor prepared by mixing is 4 parts diammonium phosphate to 1 part sodium nitrate.

(1) For wet blasting, 2 pounds of the rust inhibitor solution are dissolved in 15 gallons of water. This resulting solution can be added to 300 pounds of abrasive in the blasting machine or it can be pumped directly into the discharge line.

(2) For washing down spent abrasives, 2 pounds of prepared rust inhibitor solution are dissolved in 40 gallons of water.

**3-19. Degrees of Blast Cleaning.** Five degrees of blast cleaning are defined below.

a. White-metal Blast. Blast cleaning to white-metal is the highest degree of blast cleaning and is used for coatings which must withstand exposure to very corrosive atmospheres where the high cost of surface preparation is considered to be warranted. Blast cleaning to white-metal completely removes all rust, mill scale, and other contaminants from the surface, and assists in maximum paint system performance.

b. Near-white Metal Blast. With blast cleaning to near-white metal the blasted surface will show shadows, streaks, or discolorations, but they will appear across the general surface area and not be concentrated in spots. Evaluation of the completed cleaning job with near-white metal blast must be by visual judgment. This surface preparation results in a 10 to 35 percent savings over white-metal blasting and has proved to be adequate for many of the special coatings developed for long-term protection in moderately severe environments. Near-white metal blast is the most cost-effective standard for most ship surface preparation where abrasive blasting to bare metal is specified.

c. Commercial Blast. Commercial blast is the removal of all loose scale, rust, and other surface contaminants. This method of surface preparation will result in a high degree of cleaning and is considered adequate to the long life of the majority of paint systems under normal exposure conditions.

d. Brush-Off Blasting. Brush-off blasting is a relatively low-cost method of cleaning to remove old finishes in poor condition, loose rust, and loose mill scale. Brush-off blasting is not intended for use where severe corrosion is prevalent. It is intended to replace handtool and power tool cleaning if blast cleaning equipment is available.

e. Hydroblasting. Water blasting at pump pressure averaging 6,000 to 10,000 $lb/in^2$ is essentially a surface cleaning method used to remove surface contaminants, light marine fouling, loose paint, and mild rusting. The hydroblast method is generally used for cleaning good surfaces with less than 10 percent marine fouling, paint defects, or corrosion.

(1) Surfaces shall be dry before painting; crevices and corners must be carefully inspected, isolated areas with paint defects shall be further prepared by the method described in paragraphs 3-10 and 3-11.

(2) To spot-clean corroded areas, sand may be injected into the high-pressure water stream. The hydroblast manufacturer's instructions should be consulted for grit sizes, pressure, and special precautions. If the manufacturer's direction is not specific, 100-mesh abrasive is suggested.

**3-20. Solvent Cleaning.** Solvent cleaning prepares surfaces by removing oil, grease, dirt, chemical paint stripper residues and other foreign matter prior to painting or mechanical treatment. Solvents clean by dissolving and diluting to permit contaminants to be wiped or washed off the surface.

a. Solvent Cleaning Procedures. The simplest procedure is to first remove soil and other dry materials with a wire brush. The surface is then scrubbed with brushes or rags saturated with solvent, and clean rags are used to rinse and wipe dry. Immersing the work in the solvent or spraying solvent over the surface is a more effective method. With either method, the solvent quickly becomes contaminated, so it is essential that several clean solvent rinses be applied. An effective solvent for cleaning under normal conditons is mineral spirits.

b. Solvent Safety Precuations. Toxic solvents and solvents with low flashpoints present serious hazards to health and safety. Solvents shall not be used for cleaning if their flashpoints are below 37.8°C (100°F), or their maximum allowable concentrations (MAC) are less than 100 p/m. Safety precautions to be followed are described in paragraph 2-22. Safety Precautions for Solvent and Chemical Cleaning.

c. Recommended Solvents. Solvents recommended for cleaning surfaces prior to painting are:

(1) Mineral spirits, NSN 8010-00-558-7026 (5 gallons).

(2) EGM ether, NSN 6810-00-222-2751 (5 gallons).

**WARNING**

**Although nonflammable paint strippers and removers eliminate fire hazards, they are toxic and can be hazardous to personnel.**

### 3-21. Paint Remover Cleaning.

a. Paint Remover Uses. Removers are available in flammable and nonflammable types and as a liquid or semipaste. While most paint removers require scraping or use of steel wool to physically remove the softened paint, types of paint removers are available that allow the loosened finish to be flushed off with steam or hot water. Many of the flammable and nonflammable removers contain paraffin wax to retard evaporation. It is essential that any wax residue be removed from the surface prior to painting to prevent loss of adhesion of the applied coating. In such instances, follow the manufacturer's label directions or use mineral spirits to remove any wax residue.

b. Paint Removers Safety Precautions. Safety precautions and special requirements, such as proper ventilation, which shall be observed when working with these substances, are described in paragraph 2-23. Safety Precautions for Paint Strippers.

### 3-22. Steam Cleaning.

a. The steam cleaning method of preparing surfaces for painting involves using steam or hot water under pressure. P-C-437 steam cleaning compound can be included for added effectiveness. The steam or hot water removes oil and grease by liquifying these contaminants (because of the high temperature), then emulsifying and diluting them with water. When steam cleaning is used on some types of old paint, the old paint becomes swollen and loosened. Steam cleaning is commonly used to remove heavy dirt deposits, soot, and grime. Wire brushing or brush-off blast cleaning may be necessary to complete the residue removal.

b. The workman should be provided with a hat or cap, a faceshield, a heavy rubber apron, oilskin or rubber trousers, knee-length rubber boots drawn under the trouser legs, a heavy rubber coat, and rubber gloves covering canvas gloves. If the air temperature is excessive causing the worker to suffer excessively from heat, equipment could be limited to knee boots worn under the trousers, an oiled (or plastic) apron, gloves, and faceshield. During steam cleaning operations, adequate ventilation, natural or forced, should be provided.

**3-23. Removal of Thin Film Rust-Preventive Compound.** Steam should be used to remove thin-film rust preventive compound, MIL-C-16173, Grade 1, where large surface areas are involved, or where the rust preventive compound hardened with age. For small areas it can be effectively removed with an aromatic hydrocarbon solvent of petroleum naphtha or coal tar naphtha MIL-N15178.

**3-24. Removal of Metal Conditioning and Thin Film Rust-Preventive Compounds.** Whenever practical, mixture of grade 1 thin-film rust preventive compound and metal conditioning compound shall be removed by steaming. When straight steam is not successful, the procedures described in the paragraphs below are recommended. Health hazards are described in paragraph 2-14, Health Hazards and Personnel Exposure Limit Values for Certain Paint Ingredients.

a. Naphta-Rosin Soap. Mix Hercules Powder Dresinate 87 (a liquid sodium rosin soap) and highflash coal tar naphtha in 1:2 weight ratio. Stir until a homogenous mixture is obtained. Brush this cleaning compound on approximately 30 square feet of area. Allow the material to penetrate into the preservative film for about 5 minutes. If the cleaner appears to be drying, reapply a small amount. Rinse the surface with a stream of hot water at about 90 to 100 pounds pressure. Repeat the cleaning cycle over the same area, if necessary. Two cleaning cycles should be sufficient. The Naphtha-rosin-soap mixture has a flashpoint of 40.6°C (105°F) and its use requires fire precautions equivalent to those observed when spray painting.

b. Methylene Chloride (Dichlord-Methane) Paint Remover. The use of methylene chloride-type paint removers, containing a minimum of 70 percent by weight of methylene chloride conforming to Fed Spec TT-R-251, Type III or IV, followed by steaming, has been found effective for removing thin-film rust-preventive compounds, especially if the mixture has been applied over paint.

(1) Brush the cleaning compound liberally on the preventive-coated surface. Allow the material to penetrate into the preservative film for about 15 minutes. If the cleaner appears to be drying, reapply. Direct a jet of steam to the area to be cleaned, holding the gun top 1 to 2 inches from the surface. The steam gun should have a 1/2-inch nozzle (approximately).

(2) If any preservative compounds or loose paint remain, brush more cleaning material onto the surface, allow it to soak again for 15 minutes, and steam the area. In extreme cases, this cycle may have to be repeated once more.

### 3-25. Hand Cleaning of Ships' Bilges.

a. Hand Cleaning Use. The hand-cleaning method is used solely to prepare bilge surfaces for repainting, as some routine methods of cleaning bilges for other purposes are inadequate for paint preparation. Follow precautions described in paragraph 3-20.b.

b. Hand-Cleaning Procedures. When hand-cleaning procedures are implemented, work sections no larger than 200 to 300 square feet should be cleaned at a time. Longitudinal and transverse structural members can be used as boundaries to define the work sections. Each section should be fully cleaned and primed before work is started on the next section. The procedure is essentially hand cleaning, with the assistance of detergent solutions to aid in soil removal. (Detergent, Liquid, Nonionic MIL-D-16791 Type I, NSN 7930-00-282-9701 (5 gal Pail)).

**3-26. Cleaning Aged, Inorganic Zinc-Coated Surfaces.** When cleaning an aged, inorganic zinc-coated surface for recoating, the cleaning methods described in this paragraph should be used, depending upon the conditions to which the inorganic zinc coating has been subjected. If the inorganic zinc has had heavy traffic and physical wear, or if the existing topcoating has been work away to the inorganic zinc, the zinc-coating should be thoroughly scrubbed with a cleaning solution prepared by mixing 8 pounds of sodium metasilicate and 1 gallon of detergent (MIL-D-16791, Type I) with sufficient water to make 30 gallons of solution. Flush the cleaned surface with fresh water to remove loosened grime and cleaning solution and allow to dry. Lightly roughen the surface either by mechanical means or by abrasive brush-blasting.

**3-27. Tank Surface Preparation.** When cleaning tanks, comply with requirements for gas-freeing, safety engineering, and oxygen sufficiency. Install explosion-proof ventilation equipment and ventilate tank.

a. Tank Interior Cleaning. Install fresh water hose lines. Ensure that the hoses extend to the tank bottom, continue ventilating, enter tank, and wash down all interior surfaces with a high-velocity stream of freshwater. Remove the sludge to the sludge tank and muck out as necessary. Ventilate to dry tank surfaces. Remove residual water and oil from the tank bottom.

(1) Portable tank cleaning machines are readily available from the commercial industry. They use a rotating nozzle and a high pressure stream of water to remove sludge, rust, loose paint, and scale. Normally they are used to clean cargo tanks on larger vessels.

(2) Using nonsparking power tools (or hand scrapers if power tools are unavailable), remove all adhering sludge or deposits, rust, loose mill scale, and loose paint. Tightly adhering paint may be retained if the surface is subsequently roughened by sanding or hand wire-brushing. Burnishing or polishing of any of the surfaces shall be avoided. Wash away debris with fuel oil.

b. Repeat steps given in paragraphs above until all the sludge, dirt, deposits, rust, and loose mil scale or paint have been removed. Wash the cleaned area with cleaning solvent (Fed Spec P-D-680 or equivalent) until a solvent-wet rag remains clean.

## SECTION 4 PAINT EQUIPMENT, GAGES, AND MATERIALS

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**4-1. Introduction.** The selection of the proper equipment and materials for any painting job requires a general knowledge of the equipment and materials needed to do the job correctly. The different tools that are available for the application of paints and for testing are described in this section. Also given in this section is information on the requisition, storage, and testing of paints.

**4-2. Paint Equipment.** Tools used for the application of paint shall be of first quality and maintained in perfect working condition at all times. The types of tools and their care and maintenance are described below.

a. Paintbrushes. Brushes are identified by the type of bristle used; natural, synthetic, or a mixture of each. The types of brushes available through the National Supply System are listed in table 4-1. The various types of bristles, their uses, and their advantages and disadvantages are described below.

(1) Chinese Hog Bristles. Chinese hog bristles are the finest of the natural bristles because of their length, durability, and resiliency. Hog bristle has a unique characteristic in that the bristle end forks out (flags) like a tree branch and permits more paint to be carried on the brush. In addition, the hog bristle flagging leaves finer brush marks which flow together readily and result in a smooth finish.

(2) Horsehair Bristles. Horsehair bristles are used in inexpensive brushes and are an unsatisfactory substitute for hog bristles. The ends of the horsehair bristles do not flag and quickly become limp. They also hold far less paint and do not spread the paint as well. Brush marks left in the applied coating tend to be coarse and do not level as smoothly.

**NOTE**

**Some brushes contain a mixture of hog bristle and horsehair and their quality depends upon the percentage of each type used.**

(3) Other Animal Hair Brushes. Animal hair is used in fine brushes for special purposes. Badger hair, for example, is used for a particularly good varnish brush. Squirrel and sable are ideal for striping, lining, lettering, and freehand art brushed.

(4) Nylon Brushes. Nylon is the most common synthetic used in paint brushes. By artifically exploding the ends and kinking the fibers, manufacturers have increased the paint load nylon can carry and have reduced the coarseness of nylon brush marks. Nylon is almost always superior to horsehair. Nylon brushes are recommended for use with latex paint because water does not cause any appreciable swelling of nylon bristles. The fact that nylon is a synthetic substance, makes nylon brushes unsuitable for applying lacquer, shellac, many creosote products, and any other coating that would soften or dissolve nylon bristles.

### 4-3. Brush Care and Maintenance.

a. Before using, rinse brushes with paint thinner. Brushes that are to be reused the following day need to be marked for white light colors, or dark colors. Brushes should be suspended by the handle in a closed container, with the bristles immersed in paint thinner or linseed oil to just below the bottom ferrule. The weight of the brush should not rest upon the bristles.

b. Brushes that are not to be reused immediately shall be cleaned with thinner or some other solvent (at least three cleanings), and then washed with detergent and water. Brushes shall be stored suspended from racks by the handle or wrapped in paper and stored in a flat position.

**4-4. Paint Rollers.** The selection of a paint roller for a job depends upon the type of paint being used and the surface to be coated.

a. Roller Description. A paint roller is a cylindrical sleeve or cover which slips onto a rotatable cage. The inside diameter of the cover is 1-1/2 to 2-1/4 inches. In length, covers are 3, 4, 7 and 9 inches. Special rollers are available in lengths from 1-1/2 to 18 inches. The types of roller that are available through the National Supply System are listed in table 4-1.

b. Types of Roller Covers. Proper paint application depends upon the selection of a cover with the desired fabric and fabric thickness (nap length). Selection is based on the type of paint to be used and the smoothness or roughness of the surface to be painted. The fabric used in roller covers are:

(1) Lambs Wool (Pelt) is the most solvent-resistant type of material used and is available in nap length up to 1-1/4 inches. Lambs wool is recommended for application on semi-smooth and rough surface; it mats badly in water and is not recommended for water-base paints.

(2) Mohair is made primarily of angora hair. It is solvent-resistant and is supplied in 3/16- to 1/4-inch nap lengths. Mohair is recommended for synthetic enamels and for use on smooth surfaces, and can be used with water-base paints.

(3) Dynel is modified acrylic fiber which has excellent resistance to water. It is best for application of conventional water-base paints and solvent-base paints, except those which contain strong solvents such as ketones. Dynel is available in a range of nap lengths from 1/4 to 1-1/4 inches.

(4) Dacron is a synthetic fiber which is somewhat softer than Dynel. It is best suited for exterior oil or latex paints. Dacron is available in nap lengths ranging from 5/16 - to 1/2-inch.

(5) Rayon roller covers are not recommended because of poor results generally obtained. In addition to other disadvantages, rayon mats badly in water.

TABLE 4-1 BRUSHES AND ROLLERS

| Identification | Applicator Width (in.) | NSN |
|---|---|---|
| Flat paintbrush | 1 | 8020-00-899-7920 |
| Flat paintbrush | 3 | 8020-00-597-4770 |
| Flat paintbrush | 4 | 8020-00-597-4784 |
| Flat paintbrush | 5 | 8020-00-597-4781 |
| Paint applicator | 7 | 8020-00-282-6496 |
| Paint applicator | 9 | 8020-00-282-6495 |
| Paint roller tray | N/A | 8020-00-753-4911 |
| Paint roller, replacement | 7 | 8020-00-291-0385 |
| Paint roller, replacement | 9 | 8020-00-291-0386 |
| Roller covers | 7 | 8020-00-682-6489 |
| Roller covers | 9 | 8020-00-682-6491 |
| Roller grid for 5 gallon pails | N/A | 8020-00-721-9360 |

**4-5. Paint Spray Gun.** A conventional paint spray gun is a mechanical means of bringing air and paint together. The mixing of air with the paint atomizes (breaks up) the paint into a spray and ejects it from the spray gun nozzle. The spray equipment authorized for each ship is contained in the Revised Master Allowance List. Each spray gun consists of the gun body assembly and the removable spray head assembly.

a. Spray Gun Body Assembly. The principal parts of the spray gun body assembly are:

(1) Spreader adjustment valve: Controls the air to the air cap spreader horn holes. This valve is usually equipped with a graduated dial for adjusting the spray pattern.

(2) Air and fluid valve: Control the air and paint supply to the gun.

(3) Fluid needle adjustment valve: Controls the amount of paint passing through the nozzle by controlling the movement of the fluid needle.

(4) Locking bolt: Locks the spray head and gun body assemblies together.

b. Spray Head Assembly. The principal parts of the spray head assembly are:

(1) Air cap: Located at the front of the gun, the air cap directs air into the paint stream to atomize the paint into a spray pattern. Internal-mix guns mix the air and paint inside the air cap. External-mix guns mix the air and paint outside the air cap and are equipped with two spreader horns and a center orifice. They sometimes have auxiliary orifices through which the air is ejected and then mixed with the paint.

(2) Fluid tip: Meters and directs the paint into the air stream. The fluid tip fits inside the air cap and is available in several standard nozzle sizes. The nozzle size refers to the size of the orifice in the fluid tip.

(3) Fluid needle: Activated by the trigger and meters the paint passing through the fluid tip into the air stream.

(4) Air Pressure: The air pressure needed to maintain the proper spray gun paint application depends upon the consistency of the paint, the length of the hose, the height of the gun above the paint reservoir, and the speed of application.

**4-6. Types of Spray Guns.** Most types of conventional spray guns that are available to shipyards and ships are assembled with a pressure tank equipped for separate control of paint, and with adjustable atomizing air pressures to obtain a satisfactory spray pattern. Some nozzle combinations will perform better than others. Some assemblies clog at the air gap during continuous spraying of fast-drying paints (e.g., vinyls) and may require cleaning too frequently. Clogging may produce too small a spray pattern or may require spraying too close to the surface. Information regarding recommended air cap and fluid tip combination for specific paints can be found in equipment manufacturers' literature.

**4-7. Conventional Spray Painting Equipment Care and Maintenance.** Spray painting eqipment must be carefully maintained to achieve optimum performance and life. Spray guns, paint containers, and hoses shall be thoroughly cleaned after use.

**CAUTION**

**Never soak the assembled gun in paint thinner because it has a detrimental effect upon the packing around the fluid valve, as well as on the grease and oil in the trigger action. Do not use caustic alkaline solutions for cleaning spray guns. They destroy aluminum alloys used in gun bodies and parts.**

a. Spray Gun Cleaning.

(1) When using a pressure feed tank, release the pressure from the tank, hold a cloth over the air cap, and pull the trigger. This forces the material paint hose from the gun and run solvent through the hose. Dry out the hose with air. Spray some solvent through the gun. Remove air cap and wash off the fluid tip with solvent. Clean air cap and replace on gun. Clean out tank and reassemble for future use.

(2) When using a cup gun, hold a cloth over the openings in the air cap and pull the trigger. This forces paint back into the container. Empty cup of paint and replace with small quantity of solvent. Spray solvent in the usual way, remove air cap, and wash off fluid tip with solvent. Clean air cap and replace on gun.

b. Air Cap Cleaning. Cleaning air cap by immersing in solvent. If small holes become clogged, soak in solvent. If reaming is still necessary, use match stick, broom straw, or any other soft implement. Digging out the holes with a wire or nail may permanently damage the cap.

c. Spray Gun Lubrication. Spray guns require occasional lubrication. The fluid needle packing should be removed and softened with oil, and fluid needle shrink should be coated with grease or petrolatum. Use a few drops of light oil on all moving parts. Most spray guns are provided with oil holes for these parts.

**4-8. Airless Spray Painting.**

a. Airless spray painting is done with the use of hydraulic pressure. The equipment is similar to conventional spray equipment except that the compressor operates a hydraulic pump. Atomization of the print is accomplished by forcing it through a specially shaped orifice at between 1,500 and 3,000 $lb/in^2$. These pressures allow the paint to be applied to a surface as rapidly as the painter can move the gun.

b. Airless spraying usually permits the use of products with a higher viscosity; less thinning is required, better film build is obtained, and production is increased. The need for a single hose leading into the gun makes airless spray equipment lighter to handle and less fatiguing. The lack of overspray offers two other advantages, cleanup is easier and masking is minimized.

**4-9. Airless Spray Equipment Care and Maintenance.** All fluid connections should be tightened before starting the hydraulic pump. High-pressure fluid hose shall be checked for possible damage through kinking, bending, or abrasion. Avoid careless handling of the spray gun, especially when the nozzle has been removed. Relieve the fluid pressure before disconnecting the hose to the airless spray gun. (See paragraph 2-14. Airless Spray Safety Precautions and 3-27.a.(2).)

### 4-10. Thermal Spray.

a. Thermal Spray Characteristics. Improved corrosion control and reduced shipboard maintenance are achieved by metal-type coatings (zinc and aluminum) that are applied by the thermal spray process. They provide electrochemical (cathode) protection to surfaces exposed to the marine atmosphere and in proximity to dissimilar metals.

b. Thermal Spray Process. In the thermal spray process, aluminum or zinc in the form of a wire or powder is fed into a spray nozzle where it is melted by an oxyacetylene flame or electric arc. A blast of compressed air atomizes the molten metal into fine droplets and propels them onto the surface to be coated. The molten droplets bond to the surfaces and to each other, forming a continuous but relatively porous coating. This deposited coating provides an excellent base for further painting and can be considered the initial permanent primer coat.

(1) Surfaces that can be coated by the thermal spray process include steel, nickel, copper, and aluminum.

(2) The types of thermal spray processes are:

(a) Wire spraying using oxygen-fuel gas.

(b) Wire spraying using two consumable electrodes of the coating material.

(c) Powder spraying using oxygen-fuel gas.

(d) Powder spraying using plasma gas.

**4-11. Paint Thickness Gages.** Paint thickness is measured in terms of wet film thickness (WFT) and dry film thickness (DFT). The WFT measurements are useful in monitoring on site paint applications. The DFT measurements determine the final barrier film obtained for preservation. The gages used for the measurements of WFT and DFT are described below.

a. Minimum Film Thickness Requirements.

(1) A summary of the minimum film thickness requirements for paints used most often in the National Supply System is given in tables B-8 and B-9. These tables include supplementary data for the spreading rates as theoretical and practical coverage. The figures presented in the practical coverage columns reflect a 30-percent appliation loss which should be used in work calculations and materials cost estimates.

(2) When a measurement of paint thickness is specified, a minimum of five DFT measurements shall be recorded for every 1,000 square feet of painted surface. The average of these readings shall be the official recorded value.

b. Wet Measurements. WFT gages are used to check freshly applied coatings. The WFT multiplied by the decimal equivalent of the percentage of solids by volume gives an estimate of the DFT which will remain after the solvent has evaporated. Wet film gages to be used are described below.

(1) Interchemical WFT Gage. The interchemical WFT consists of an eccentric center wheel attached to two concentric running wheels. Rolling of the gage results in the central measuring wheel dipping into the coating. The point at which the film touches the center wheel measures the thickness of the film, which can be read on the mil scale provided on one of the running wheels. The range of the particular gage selected for use should be one in which the measured film thickness falls within the middle 80 percent of each scale. The gage is available in the ranges given in table 4-2.

(2) Nordson WFT Gage. The Norson WFT gage has several legs, with each of the inner legs some what shorter than the outer legs. The two end legs define the plane of application and penetrate through the wet film to the substrate. Consequently, some of the legs will dip into the coating while others will not touch it. The leg which is just wetted by the coating indicates the WFT.

c. DFT Measurements. Minimum DFT for the coatings listed in tables B-8 and B-9 should be determined with one of the DFT gages (or equal) described below.

(1) General Electric Type B Thickness Gage. The General Electric Type B thickness gage is a rugged, resonably portable instrument operating from a 115-volt, 60-Hz power supply. The gage operates on a magnetic principle and can be used to measure coatings only on a magnetic surface. The instrument is fast and easy to use, and can be used on slightly curved surfaces as well as on flat surfaces. It is necessary to standardize the scale with a foil or known thickness on a bare area of the same thickness and type of surface as the one on which the measurement is being made, because different surfaces will give different readings. Measurements shall not be made close to edges and corners, as this will cause variations in the readings. The accuracy of the readings vary with the thickness of foil used to standardize the instrument. For best results, the standardizing foil shall be close to the actual thickness of the paint film being measured.

(2) Elcometer Thickness Gage. The Elcometer thickness gage has different ranges available and is a light, portable instrument which fits into a coat pocket. This gage is operated by means of the variation in magnetic force between the metal surface and a self contained permanent magnet. No outside power source is necessary. Measurements can be made on slightly curved surfaces. To operate the Elcometer thickness gage, it is necessary to first standardize the dial over a bare area of the same type and thickness of metal as that on which the coating is to be measured. It is important for accuracy to hold the meter in the same plane when taking the measurements, as the gage is then set to zero. The results obtained will be satisfactory for most purposes for which field measurements are made, providing the necessary precautions for use are taken.

(3) General Electric Permanent Magnet Thickness Gage. The General Electric permanent magnet thickness gage is a portable, self-contained gage with a dual scale. The low scale ranges from 0 to 7 mils and the high scale ranges from 1 to 60 mils. The gage is also provided with a go-no-go feature which can be set for a minimum and maximum paint thickness.

(4) Mikrotest Thickness Gage. In the Mikrotest thickness portable gage, a small magnet is attached to one end of a balance which is at equilibrium; the magnet is connected through a spiral spring with a micrometer screw. To measure DFT, the spiral spring of the gage is stretched by turning the micrometer screw until the magnet is pulled away from the coated surface. The coating thickness can then be read from the calibrated disk or obtained from a calibration curve.

(5) Dermitron Electromagnetic Thickness Gage. The dermitron electromagnetic thickness gage, and other eddy-current type thickness gages are electronic instruments that measure variations in impedance of an eddy-current-inducing coil by paint coating thickness variations. Gages of this type can be used only if the electrical conductivity of a coating differs significantly from that of the substrate. Typical measurement applications involve an organic coating over aluminum or corrosion-resistant steel (CRES).

(6) Tocke Coating Inspection Gage. The Tooke coating inspection gage is an optical thickness gage. It is used to measure the thickness of different colored individual paint coats or can be used when nondestructive gages cannot be used. A cut is scribed through the film and measurements are made by means of a calibrated microscope eyepiece. After the measurements, the scribed marks shall be repainted.

**TABLE 4-2 INTERCHEMICAL
WET FILM THICKNESS GAGE**

| Range Graduations (mils) | Smallest (mils) |
|---|---|
| 0 to 0.4 | 0.02 |
| 0 to 1 | 0.05 |
| 0 to 2 | 0.1 |
| 0 to 4 | 0.2 |
| 2 to 12 | 0.5 |
| 10 to 30 | 1.0 |
| 20 to 60 | 2.0 |

**4-12. Paints and Paint Materials.** Only paints and paint materials that are in accordance with Navy standard formulas and specifications, shall be used on board Army watercraft. Paints and paint materials covered by formula designations are listed in Appendix A. Included in this table are national stock numbers (NSN) and specifications. Paints and paint materials covered by specifications, but not by formula designations, are listed in Appendix A.

**4-13. Paint Requisition.** Paint requisitions shall be submitted only for paints presented in this section. The formula or specification numbers of the paints to be ordered must be stated on the requisition. If only the formula number is given, the publication date of this TB shall also be given.

**4-14. Paint Storeroom.** Paints on board watercraft shall be stored in a storeroom designated for flammable liquids (paint locker). The store room should be clean, cool, and dry.

a. Paint Storage. Paints shall be stored in tightly sealed cans and marked with the name, formula number, and manufacture date. When new stocks are obtained, they should be stored so that the oldest paint will be used first.

b. Paint Inspections. The contents of any paint can more than 2 years old shall be inspected and, if unfit, surveyed. If uncertain as to whether the paint is suitable for reworking, dispose of paint.

**4-15. Paint Usability Testing.** As the explanations of the shelf life codes indicate, paint products require frequent extensions of shelf life, using simple on site methods of usability testing and resorting to laboratory analysis only in instances where questionable paint properties are encountered.

a. The procedure used for testing the paint for shelf life extensions is to open one container from each separate batch number and stir the paint product. The stirred paint product should result in a homogenous mixture free of abnormal clumping, jelling, skinning, or other objectionable properties.

b. Apply a coating of the test paint on a small panel. It should dry overnight to give a uniform film. Two component paints should be mixed in the appropriate proportions and similarly tested.

## SECTION 5 PAINTING APPLICATION REQUIREMENTS

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**5-1. General.** There are basic requirements that shall be met whenever significant painting is accomplished aboard a US Army vessel. Section 1 contain guidelines on when to paint. This section covers basic paint application techniques that shall be followed.

**5-2. Painting Guidance.** When painting schedules conflict with the requirements given in this section guidance on paint compatibility and touchup procedures shall be obtained from the National Maintenance Point (NMP).

**5-3. Painting Records, Reports, and Documentation.** Records of significant shipboard paint application shall be kept current. These include routine maintenance that requires painting; regular overhauls; drydocking; and major alterations.

**5-4. Painting Schedules and Drydocking Reports.** A report of vessel drydocking, painting and condition of vessel bottom will be submitted to the NMP to exhibit that the time periods specified by AR 750-1 are complied with. This report must be submitted within 90 days of drydocking completion. The report will be mailed to CDR, TROSCOM, ATTN: AMSTR-MCFM, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798.

**5-5. Basic Preparations.** To obtain optimum performance from a coating, certain basic procedures must be followed, regardless of the type of equipment selected for paint application.

a. Temperature, Wind, and Humidity Requirements. It is essential for surface and surrounding temperatures to be between 10°C and 32.2°C (50°F and 90°F) for water-thinned coatings, and 1.6°C and 35.°C (35°F and 95°F) for other coatings, unless the manufacturer specifies otherwise. Paint should be applied only when surfaces are completely dry and surface temperature is at least 2.8°C (5°F) above the dewpoint. The paint material should be maintained at a temperature of 18.3°C to 29.4°C (65°F to 85°F) at all times. Paint shall not be applied when the temperature is expected to drop to freezing before the paint has dried. Wind velocity should be less than 15 miles per hour and relative humidity less than 80 percent.

b. Paint Mixing. Paints shall not be used until they are thoroughly mixed. Improper mixing is considered to be one of the principal reasons for poor paint performance. Tinting pastes, if used, must be mixed in a similar manner before they are added to the paint. Pastes shall be measured carefully, and stirred in until no streaking occurs and the desired color is obtained.

(1) Mixing Procedures. Mechanical paint agitators (shakers) shall be used whenever possible. If a shaker is not available, the paint must be stirred until all lumps, cakes, and sediments are completely dispersed. Stirring should be done in accordance with the following procedures:

(a) Open the paint can. If a skin has formed on the paint surface, it should be carefully removed and discarded.

(b) Pour the top 2/3 of the paint into another can.

(c) Stir the pigment and liquid left in the first can until the paint is smooth; a paint mixing attachment for use with an electric or pneumatic drill is suitable. See section 2 for applicable safety precautions.

(d) Gradually add contents of the second can to the first can, continuing to stir.

(e) Continue to mix by pouring the paint back and forth from one can to the other (boxing) until uniformly smooth.

(2) Paint Straining. Strain the paint through a wire screen or cheese cloth to remove any particles or skins that remain undissolved after stirring.

**5-6. Multicoating Applciations.** When successive coats of the same paint are used, and tinting is permitted, each coat should be tinted differently to aid in detrmining proper application and to ensure complete coverage. Sufficient time must be allowed for each coat to dry thoroughly before topcoating or subjecting the painted surface to service conditions such as immersion.

**5-7. Basic Painting Procedures.** The basic techniques, procedures, and methods used in the application of paints are described in Sections 5, 6, and 7.

**NOTE**

**Before starting any painting job, ensure that surface preparation has been completed as directed in section 3. Apply the first coat of paint as soon as practicable after surface preparation has been accomplished.**

**5-8. Paintbrush Techniques.** The techniques used in the application of paint with a brush are as follows.

a. Painting Procedures. Start major work on overhead areas first, then work downward. Begin painting at a corner or some other logical vertical division. Cover only that areas which can be easily reached without moving ladders. Work downward, painting progressive sections to the deck level, then start at the top of the adjacent area and work down again. Paint trim, doors, or similar areas after bulkheads and other major surfaces are completed.

b. Coating Application. Dip the brush into the paint up to 1/2 the bristle length. Withdraw the brush and tap it against the inside of the bucket to remove excess paint. Hold the brush at an angle of 45° to the work. Make several light strokes in the areas to be painted. This will transfer much of the paint to the surface. Then spread the paint evenly and uniformly. Do not bear down on the brush.

(1) When one section of the surface is painted, adjacent areas should be painted so that the brush strokes are completed by sweeping the brush into the wet edge of the paint previously applied. This helps eliminate lap marks and provides a more even coating.

(2) Finally, cross-brush lightly to smooth the painted surface and to eliminate brush or sag marks. Very fast-drying finishes will not permit much brushing and cross-lapping; in such cases, the paint shall be applied, spread rapidly, then allowed to dry undisturbed. Going back over a fast-drying paint will cause piling up of the coating.

**5-9. Paint Roller Technique.** 'The technique used in the application of paint with a roller are as follows:

a. Paint to Roller Procedures. To apply paint with a roller, pour the premixed paint into the tray to about 1/2 the tray depth. Immerse the roller completely, then roll it back and forth along the ramp to coat the cover completely. Remove any excess paint. As an alternative to using the tray, place the specially designed galvanized wire screen (grid) into a 5-gallon can of the paint. This screen attaches to the can and remains at the correct angle to load and spread paint onto the roller. The first load of paint on a roller should be worked out on newspaper to remove entrapped air from the roller cover; it is then ready to apply to a surface.

b. Paint Application.

(1) When a roller is passed over a surface, thousands of tiny fibers continually compress and expand, releasing the coating and wetting the surface. This application of paint is in sharp contrast to other application methods which depend upon the skill and technique of the painter. The uniformity of application by roller is less susceptible to variance because of painter ability than other methods.

(2) Always roll paint onto the surface, working from the dry area into the just painted area. Never roll completely in the same or one direction. One good technique is to roll the paint onto the surface in a W pattern and then fill in the area inside the W using horizontal or vertical strokes. Don't roll

too fast. Avoid, spinning the roller at the end of the stroke. Always feather out final strokes to pick up any excess paint on the surface. Feathering is done by rolling out the final stroke with minimal pressure.

**5-10. Conventional Spray Painting Techniques.** Conventional spray printing techniques are as follows.

a. Spray Painting Preparation. Before spray painting starts, ensure that the following steps are completed.

(1) Mix the paint thoroughly. Strain the paint through a wire screen or cloth to remove skin and coarse or foreign particles.

(2) Ensure that the air filter is connected to the main air supply line to prevent moisture and oil particles from mixing with the paint.

(3) Spray Pattern Adjustment. After making initial adjustments to the air and liquid pressures, make the final spray gun adjustment by observing the spray pattern. A normal spray pattern will appear as illustrated in figure 5-1, A and B.

b. Spray Gun Paint Application.

(1) The spray gun shall be held 6 to 8 inches from the surface being painted. Begin the strokes before pulling the trigger and release the trigger before ending the stroke. This prevents piling up paint at the beginning and end of each stroke. Always keep the gun at a right angle to the surface being painted. Swinging the gun in an arc results in uneven application and excessive overspray at the end of the stroke.

(2) When painting corners, first spray within 1 inch of the corner. Then holding the gun sideways, spray the corner so that both sides of the corner are sprayed at the same time. Speed of application depends upon the material being sprayed, rate of paint flow, and surface to be coated.

**5-11. Conventional Hot Spray Process.** Hot spray is an industrial term for warming paint with special equipment before spraying with conventional spray equipment. Warm spray is often a better term to use in describing this process because most navy paints, when warmed, do not exceed 48.9°C (120°F). Paints which are heated have reduced viscosity. Benefits of the hot spray process are:

a. Elimination or reduction of gaps (holidays) in the film.

b. Smoother and less porous finishes with fewer dimpled areas (orange peels), sags, or runs.

c. Reduction in paint waste from overspray or fogging (misting).

d. Elimination of need to add paint thinner to reduce paint to spraying consistency.

e. Reduction of atomizing air pressures.

f. Only minor gun adjustments are required over a wide range of weather conditions because paint viscosities are controlled by maintaining a constant spraying temperature, thereby achieving more consistent results.

g. Application of heavier coats, thereby reducing the number of coats required for a multiple-coat system, and total application time.

h. Reduction of cleanup time where paint is recirculated overnight.

**5-12. Imperfect Spray Patterns.** Imperfect spray patterns are caused by clogging of the gun's paint or air passages, or improper balancing of the air or fluid pressures.

a. Clogged Passages. Imperfect spray patterns caused by clogged passages will take the forms illustrated in figure 5-1 and listed below:

(1) Heavy top pattern (figure 5-1, C).

(2) Heavy bottom pattern (figure 5-1, D).

(3) Heavy right-side pattern (figure 5-1, E).

(4) Heavy left-side pattern (figure 5-1, F).

b. Improper Air and Fluid Pressures. Imperfect spray patterns caused by improper balance of air and fluid pressures will take one of the following forms:

(1) Heavy center pattern (figure 5-1, G) caused by:

(a) Spreader adjustment valve set too low.

(b) Excessive fluid pressure.

(c) Viscosity of paint too high (too thick).

(2) Split spray pattern (figure 5-1, H) caused by:

(a) Spreader adjustment valve set too high.

(b) Inadequate fluid pressure.

(c) Viscosity of paint too low (too thin).

**5-13. Common Spray Paint Defects.**

a. Some of the common causes of an orange peel finish are:

(1) Too high or too low air pressure on the spray gun.

(2) Paint viscosity too high or incorrect thinners used.

(3) Inadequate surface preparation.

(4) Holding the gun so close to the surface that air ripples result.

b. Another common defect in spraying is mist or fog. These defects are caused by the following:

(1) Over atomization caused by:

(a) Air pressure too high.

(b) Fluid pressure too low.

(c) Wrong air cap for material used.

(d) Wrong fluid tip for material used.

(2) Improper use of gun caused by:

(a) Incorrect stroking.

(b) Gun too far from surface.

**WARNING**

**Considerable care must be exercised in operating airless spray paint equipment because of the high pressure used. Refer to section 2 for safety precautions. (Para 2-14. Airless Spray Safety Precautions.)**

**5-14. Airless Spray Technique.** Airless spraying is a high production method of coating application. Material can be applied to surfaces as fast as the painter can move the gun. Since the degree of atomization with airless spray is not sufficiently fine, this method should not be used for fine finishing. The high rate of speed plus the release of pressure, causes atomization without compressed air. There is no air turbulence to deflect the paint, which is the usual cause of overspray in the conventional method. The absence of air also reduces rebounding of the paint in crevices and corners, providing more uniform coverage.

### 5-15. Dip Painting Techniques.

a. Dip painting involves dipping an article to be painted into a tank filled with paint. The tank should be just large enough to permit convenient dipping of the article. An agitation method must be provided to keep the paint uniformly mixed.

b. Give careful consideration to the type and amount of thinner used in the operation of a dip tank. The optimum consistency is that which provides coverage at the highest point, yet allows the paint to draw off well from the lowest point of the article being coated. Suspend the article in a manner which provides the shortest drain without creating paint pockets. Dip the article in the paint, remove slowly and regularly, and allow to drain. When it is apparent that dipping operations will be interrupted for several hours, remove the paint and place it in sealed containers.

**5-16. Paint Failures.** The types of paint failures to look for when inspecting a surface before or after an application of paint are described below.

a. Alligatoring or Checking. Alligatoring, or checking, exists when the outer layer of paint is broken and underlying paint coats are visible, often presenting an appearance similar to alligator hide. This may be caused by applying paint:

(1) To unseasoned wood.

(2) Over a relatively soft undercoat.

(3) Over previous coats before they have dried.

(4) Of a hard drying nonelastic type over a more elastic paint.

b. Cracking. Cracking exists when a break extends through to the painted surface. Paints which lack elasticity because of aging or other causes can no longer contract or expand with moisture and temperature changes and, therefore, crack.

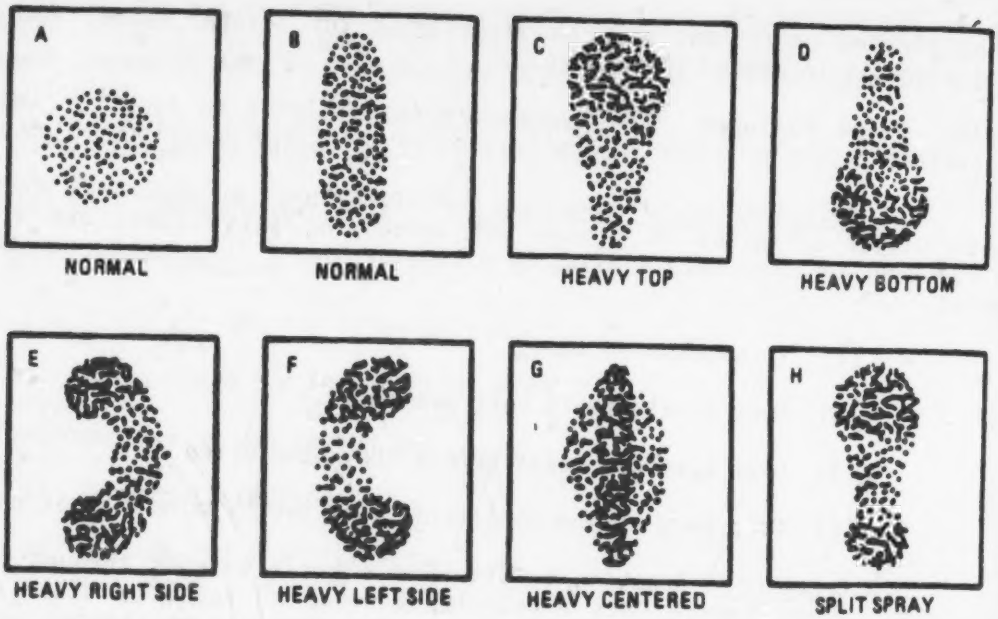
c. Flaking, Scaling, and Peeling. Flaking, scaling, and peeling are characterized by the detachment of pieces of paint, generally irregular in shape. When pieces are small, it is termed flaking; when pieces average over 1/4 inch, it is termed scaling; when pieces are larger (over 1 inch), it is termed peeling. Flaking and scaling usually follow cracking and have the same causes. Peeling is often caused by the presence of moisture behind the film or by incompatibility of paint films.

d. Bleeding. Bleeding exists when the color of a previous coat is absorbed into the topcoat. Bleeding is usually caused by the solubility of the color ingredient of the undercoat in the vehicle of the new coat.

e. Blistering. Blistering occurs when the topcoat detaches from the underlying surface in unbroken areas as a result of gases or liquid (usually water) forming beneath the coating.

f. Chalking. Chalking is characterized by the presence of a loose powder evolved from the paint film, at or just beneath the surface. Chalking may be detected by rubbing the film under the fingertips. Slight chalking is desirable for some applications because the surface becomes self cleaning. The degree of chalking is determined by the composition of the paint.

g. Discoloration. Discoloration is an alteration in the original color and includes yellowing, darkening, fading, and mottling.



NORMAL

NORMAL

HEAVY TOP

HEAVY BOTTOM

HEAVY RIGHT SIDE

HEAVY LEFT SIDE

HEAVY CENTERED

SPLIT SPRAY

*Figure 5-1 Spray Paint Patterns*

## SECTION 6 PAINT APPLICATION PROCEDURES

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**6-1. General.** Detailed paint application procedures are frequently presented in specialty manuals, military or federal specifications and standards.

**6-2. Epoxy-Polyamide Coatings (MIL-P-24441).**

a. Description. Epoxy-polyamide coatings are similar to other epoxy coatings in that they consist of a two-component system that includes a pigmented polyamide resin (A component) and an epoxy resin (B component). Once they are mixed together and applied as a paint film, the coating cures to a hard film by chemical conversion. During this curing period, the solvents used to maintain the composition in liquid form are released by evaporation.

b. Formulas. Epoxy-polyamide coating (MIL-P-24441) consists of seven individual formulations. Formulas 150 through 156. These coatings are suitable for use in tanks, bilges, wet spaces, and on exterior surfaces. Epoxy-polyamide coatings are available in 10-gallon, and 2-quart kits.

c. Epoxy-Polyamide Coating Hazards.

(1) All MIL-P-24441 formulations have a minimum flashpoint of 34°C (95°F) and do not require the type of precautions against fire that are essential to vinyl paints. Since solvent fumes epoxy paint systems are potentially hazardous, suitable precautions shall be taken to prevent fires and to protect personnel from fumes and fume inhalation (particularly in confined spaces). Precautions against such hazards must be exercised at all times.

(2) In addition to fire and vapor hazards, these epoxy coatings can cause allergic reactions when allowed to come in contact with the skin. Prompt skin cleanup is recommended using soap and water, not solvent. Solvent will thin and spread the paint over the skin and increasing the hazard of a delayed allergic reaction.

d. Surface Preparation. The single factor most affecting the performance of the MIL-P-24441 epoxy-polyamide coatings is the preparation of the surface to be coated, both as to method and to degree of care. Surfaces to be coated should be completely free from rust, loose paint, dirt, scale, oil, grease, salt deposits, moisture, and other contaminants. Surface preparation procedures detailed in section 3 apply and are supplemented by requirements given in this section.

(1) Bare Surfaces. When painted surfaces show evidence of corrosion, peeling, blistering, checking, or general disintegration, the old paint should be removed down to bare metal prior to repainting. Surfaces to be painted with the epoxy-polyamide system should be abrasive-blasted to near-white metal. In

areas where abrasive blasting is not permitted, the surfaces should be cleaned by mechanical means (disk sanding, chipping tools, or pneumatic descaler (needle gun), to remove all loose paint film and foreign matter. Since abrasive blasting will not adequately clean surfaces contaminated with oil or grease, such areas should be cleaned with solvent.

(2) Galvanized Steel. Galvanized steel should be roughened by a light abrasive blast or by mechanical means to provide a suitable painting surface.

(3) Aluminum Surfaces. Aluminum should be cleaned by light abrasive blasting, power wire brushing, or orbital sanding. Only stainless steel wire brushes, scouring pads, or aluminum oxide abrasive sanding disks shall be used. None of these materials shall have been previously used on other metal, or for the removal of copper-pigmented paint, prior to being used on aluminum.

(4) Surface Preparation of Coated Metal. Brush blasting may be used instead of blasting to bare metal in those instances where an epoxy coating is in good condition and has been applied over a well prepared surface. This method should result in a surface retaining all paint films, but free from all rust, scale, and foreign matter.

(5) Touchup Painting. When only localized areas or spots require painting, it is essential that removal of the old paint be carried back to an area of completely intact and adhering paint film. Edges of tightly adhering paint remaining around the area to be recoated shall be sanded to a smooth slope (feathered) from the intact spaces and shower stalls, remove paint film to the bare metal area. Areas of intact paint to be overcoated shall first be roughened. A tack coat shall then be applied prior to final coating.

(6) Bilges and Sumps. Structures and fittings below floor plates in machinery spaces (bilges, bilge wells, and sumps) may require special cleaning method for bilges on surface ships at shipyards. A handcleaning method for bilges is described in paragraph 3-25. Hand Cleaning of Ships' Bilges.

(7) Coating Over Inorganic Zinc Coatings. If epoxy coatings are applied over aged, inorganic zinc coatings, or if the topcoat over an inorganic zinc coating has been removed by mechanical damage, the inorganic zinc coating should be scrubbed and washed with a detergent solution. This solution is prepared by mixing 8 pounds of sodium metasilicate, and 1 gallon of detergent (MIL-D-16791, Type I) with sufficient freshwater to make 30 gallons of solution. Flush the cleaned surface with freshwater to remove the loosened dirt, grime, and cleaning solution. Allow surface to dry. Lightly roughen the dry surface by mechanical means, feathering the edges of the intact topcoat. Reapply the topcoat system. Apply the first coat of the topcoat system as a thin coating over the inorganic zinc and allow to dry. This fills the pores and seals the surface of the inorganic zinc coating. Follow this procedure with the complete topcoat system.

(8) Wet Spaces. In wet spaces and shower stalls, remove corrosion products and cracked or loose paint by mechanical means. Retain tightly adhering paint. Edges of paint film around the area to be recoated must be feathered. Remove stains on old paint by solvent cleaning, detergent cleaning, or both. Rinse with clean freshwater and dry before repainting. Apply primer on the bare metal areas so it overlaps the intact paint. Apply topcoats over the spot-primed bare areas and the remaining intact painted surfaces. Intact painted areas do not require priming.

e. Mixing Epoxy-Polyamide Coatings. Epoxy-polyamide coatings are in measured amounts that must be mixed together in exact proportions to ensure the correct chemical reaction.

(1) Mixing Ratio. The mixing ratios of the MIL-P-24441 coatings are all 1:1 by volume; for example, 5 gallons of component A to 5 gallons of component B.

**NOTE**

**The individual componets of the various formulas are not interchangeable.**

(2) Mixing Procedures. Each component shall be thoroughly stirred prior to mixing the componets together. After mixing equal volumes of the two components, this mixture shall again be thoroughly stirred until well blended. The induction or stand-in time shall be adhered to. Induction time is defined as that time immediately following the mixing together of components A and B during which the critical chemical reaction period of these components is initiated. This reaction period is essential to ensure the complete curing of the coating.

(3) MIL-P-24441 Induction Times. The approximate temperature of the paint components in storage should be estimated to judge the amount of induction time and the pot life that might be expected. The jobsite application temperature will affect the time required for the paint to cure, and must be considered in estimating induction time, cure time, and the effect of batch size on these functions.

(a) The induction times listed in table A-5 are based on a 10-gallon batch. Smaller batches require a longer induction time. When these paints are to be applied at a jobsite having temperatures in the range of 1.6°C to 10°C (35°F to 50°F), it is essential that induction occur in a warm area (21.1°C (70°F)). This ensures that the coating will fully cure. When the induction period is completed, the paint is carried to the jobsite.

(b) To ensure that the reaction proceeds uniformly, the paint should be stirred periodically during its induction period. This action prevents localized overheating or hot spots within the paint mixture.

f. Epoxy-Polyamide Coating Application. Epoxy-polyamide coatings (MIL-P-24441) may be applied by brushing, spraying, and rolling or dip coating. Application is described below.

(1) Thinning. Up to 1 pint of ethylene glycol monoethyl (EGM) ether for each gallon of mixed paint may be added if the paint has thickened appreciably during cold temperature application, or when necessary to improve application characteristics. When applied at the proper thicknesses, without thinning, these paints will have no tendency to sag.

(2) Application Thickness. Unless otherwise specified, apply each coat of paint to produce approximately 3 mils dry film thickness (DFT). Application which yields in excess of 4.0 mils DFT should be avoided.

(a) Brush Application. During maintenance painting, brush application is recommended for the first coat of paint over mechanically cleaned surfaces and handcleaned bilges. The brushing effort forces the paint into the surface profile and displaces any traces of surface contaminants.

(b) Spray Application. MIL-P-24441 paints should be sprayed with the normal spray guns and normal spray pot pressures. The spray gun should be equipped with a middle-side (D) needle and nozzle setup. Both conventional and airless spray equipment are suitable for use.

(3) Tack Coat for Topcoat Paints.

(a) When vinyl antifouling Formula 121, Formula 129, Fed Spec TT-E-490, and other nonepoxy topcoats are applied over the epoxy, the first coat of the topcoat must be applied before the final coat of epoxy paint has hardened. The epoxy should still be slightly tacky when the first coat of the topcoat is applied. This tacky period generally occurs between 4 and 6 hours after the epoxy has been applied, depending upon temperature and weather conditions. If the epoxy is hard (usually after 8 hours), a tack or mist coat of 1 to 2 mils wet film thickness (WFT) must be applied and dried to a slightly tacky state before applying the first coat of the topcoat system. The tack coat should be the same as the preceding coat of the epoxy or Formula 150.

(b) If more than 7 days elapse between preservation coats of the epoxy, the surfce should be cleaned with water and detergent and rinsed clean with freshwater. If required, use solvents for grease and oil removal. Then a tack coat (1 to 2 mils WFT) of the last coat applied or Formula 150 is applied to the hard epoxy coat. It is allowed to dry approximately 4 hours before application of the next full coat of the system. This same procedure applies to aged epoxy paint systems after service, except that surface preparation methods specified in paragraphs 3-4.a. and 3-4.b apply. Formula 150 should be used as the tack coat when applying MIL-P-24441 paints over proprietary epoxy coatings.

(4) Equipment Cleanup. Since epoxy paints cure with time, due to an internal chemical reaction, the paint should not be allowed to remain in spray equipment for an extended period, especially in the sun or a warm area. Increasing temperature cures the paint more rapidly. When components A and B are mixed together, the pot life of the mixture (including the induction time) is 6 hours at 21.1°C (70°F). Pot life is longer at lower temperatures and shorter at temperatures above 21.1°C (70°F). After use, spray equipment should be cleaned by flushing and washing with EGM ether solvent. General cleanup is also done by using EGM ether solvent. Brushes and rollers should be given a final cleaning in warm soapy water, rinsed clean with warm freshwater, and hung to dry.

g. Pretreatment Primer (Formula 117) Coatings. Formula 117 is used to improve the adhesion and life of subsequently applied paints. It is used as a pretreatment primer for bare metal surfaces, underwater preservative-treated wood surfaces, and plastic surfaces (when specified) prior to primer coat application. Formula 117 may be omitted during interior painting by ship's force (paragraph j. below). It is a two-package unit consisting of 4 gallons of a resin component and 1 gallon of an acid component.

h. Pretreatment Primer Mixing. The mixing instructions for the pretreatment primer (Formula 117) shall be strictly followed.

(1) Mixing Procedure.

(a) Thoroughly mix the resin component to disperse any pigment that has settled. While stirring the resin component, slowly add the acid component. Thoroughly mix the two components. If less than 5 gallons of pretreatment are required, stir 1 volume of the acid component into 4 volumes of the resin component. For example, 1 quart of the acid component may be stirred into 1 gallon of well-mixed resin component.

(b) After mixing, the pretreatment coating is stable for approximately 8 hours. Mix only the quantity that can be applied within the 8-hour stability period. Loss of stability is not evident from the visual appearance of the mixture. Unused mixed pretreatment coating shall be discarded.

(2) Pretreatment Primer Additives. When thinning is required to obtain a continuous film, it is permissible to thin the pretreatment mixture with denatured ethyl or isopropyl alcohol. When the spray is too dry, a retarder such as butyl alcohol may be added. A commonly used spray reduction is 4 volumes of resin component, 1 volumn of the acid component, and 1 volume of alcohol. In general, guidance contained in MIL-C-8507 applies to Formula 117.

i. Pretreatment Primer Application. Before application of the pretreatment primer (Formula 117), ensure that all surfaces to be coated have been thoroughly cleaned. Apply a thin coat of Formula 117, preferably by brush, to produce a DFT of 0.3 to 0.5 mils. Coverage is approximately 215 square feet per gallon ($ft^2$/gal). Formula 117 is sufficiently dry for recoating within 30 minutes. Coat with a primer as soon as practical. Clean the painting equipment with isopropyl or denatured ethyl alcohol.

j. Safety Precautions. Safety precautions must be followed when a pretreatment coating is being applied to interior surfaces. See detailed safety precautions Section 2, para 2-12. Application of Paint in a Confined Space. All the safety precautions of, Gas Free Engineering shall be followed. All precautions and safety measures pertaining to flammable materials shall be enforced. Adequate ventilation shall be provided to prevent explosions. Care should be taken by spray gun operators to protect personnel (paragraphs 2-13.b and 2-13.c.).

**6-3. Vinyl Paint Coatings.** The procedures and precautionary highlights for the preparation and application of vinyl paints are described below. Refer to section 2 for a more detailed listing of precautions.

a. Safety Precautions.

(1) The solvents used in the vinyl systems component formulations are more flammable than the solvents in most other shipboard paints. The vapors can produce physiological and toxic effects if breathed continuously for long periods. All precautions and safety measures pertaining to flammable materials such as no smoking, welding, burning in the immediate areas, grounding of spray equipment, and elimination of chipping and other spark producing operations shall be enforced. Respirators for spray painters and explosion-proof ventilation shall be used.

(2) The spray equipment discussed in paragraphs 4-4. Paint Spray Gun and 4-5. Types of Spray Guns, was not designed specifically for the applciation

of vinyl coatings. It is possible that the spray guns may have exposed ferrous parts and, if so, are capable of producing a spark. Safety precautions shall be followed to guard against accidental ignition of the solvent vapors that are present.

b. Surface Preparation. A clean dry surface, free of contaminants, is especially critical in the application of vinyl paints. Improper surface preparation will result in unsatisfactory paint performance.

(1) Surface Cleaning. Prior to the application of vinyl paints, the removal of scale, corrosion, dirt, grease, oil, marine fouling, and other foreign matter from the surface shall be completed. The method of cleaning depends upon the amount and the type of cleaning required. For metal surfaces, abrasive blasting is the most effective method for surface preparation. A solvent wash and light blasting or mechanical roughening may be used to rid new galvanized steel of fatty material and flux componets, as well as to provide a suitable anchor pattern. This is required for satisfactory adhesion of pretreatment primer.

(2) Cleanup. During cleaning operations, considerable dust or debris will collect on otherwise clean surfaces. Depending upon weather conditions, some rusting may occur. Any contaminants on the surface to be painted must be removed prior to coating applciation.

(3) Touchup Surface Preparation.

(a) For vinyl bottom paint touchup, surfaces shall be washed down with streams of high-pressure water after docking to remove mud, slime, scum, and loose marine fouling. Light blasting may be used for removing adherent marine life from intact paint. Prior to touchup, deteriorated aras of old paint and corrosion products should be removed, and surfaces prepared as specified above. Oil and grease may be removed with suitable solvents (for example, naphtha). In some instances, use of mineral spirits may leave an oily film which prevents proper adhesion of Formula 117.

(b) To avoid after-corrosion or surface contamination, each shift shall clean only the areas that can be coated in the same shift. All cleaned surfaces shall be coated as soon as practical, including those that were cleaned of oil and grease as well as corrosive products.

c. Pretreatment. Use of pretreatment (Formula 117) on all galvanized and bare metal surfaces is mandatory to ensure adhesion of vinyl paints. Formula 117 should be applied to cleaned areas as soon as practical to prevent further surface contamination. The instructions to be followed to ensure adhesion of vinyl paint over Formula 117 are described below.

(1) Apply the first coat of vinyl primer Formula 120 over Formula 117 as soon as practial, preferably within 24 hours after Formula 117 application. Any rusted areas should be reprepared and recoated.

(2) If Formula 117 has been on long enough to pick up blasting dust, oil film, or other contaminants, prepare the surface again as specified in paragraph b. Surface Preparation.

(3) If moisture is a problem, the addition of up to a pint of ethyl or butyl alcohol per gallon of Formula 117 may eliminate the last trace of moisture and promote adhesion.

d. Vinyl Paint Mixing. Vinyl paints are best mixed by using a mechanical shaker or high-speed stirrer. Mixing is very important because the copper pigment in antifouling paint settles to the bottom of the containers during storage. All of the pigment must be thoroughly dispersed in the paint to achieve optimum antifouling properties. After agitation, the paint should be examined with a hand paddle to be sure that the contents of the container are properly mixed. The paints should be restirred as necessary to keep the pigment in suspension.

e. Vinyl Paint Application. Vinyl paints may be applied through any paint application method. They should not be applied over conventional paint films because of the softening effect of the ketone ingredient used in vinyl paints. When vinyl antifouling paints are applied over cured epoxy paints, a mist coat of the epoxy paint must be applied before the vinyl paint to assure adhesion (paragraph 6-1.f.(3) and 6-1.f.(4). Depending upon the thickness of the wet film and weather conditions, vinyl paints may be recoated within 1 hour. A minimum drying period of 24 hours, preferably longer, is necessary between the final coat and undocking to ensure solvent release.

(1) Hot and Airless Spray Application. Hot and airless sprays require special techniques that should be developed by the shipyard. Formulas 119, 120, and 121 should never be heated over 48.9°C (120°F) in hot spray applications, nor subjected to a heat source for more than 3 hours. The paint may gel if these time and temperature limits are exceeded.

(2) Conventional Spray Application. The actual application of vinyl coatings by spray requires more technique and a better understanding of spray equipment (paragraph 4-5. Types of Spray Guns.) than is usually exercised with other types of finishes. Since vinyl paints are comparatively low in non-volatile film-forming materials, the operator must make slow steady passes with the spray gun. Supervisors should constantly restrain the sprayers from going too fast. The speed of the passes has a direct relation to the DFT which, in turn, influences the ultimate performance of the system.

(3) There are many variables in spraying vinyl paints, some of which are influenced by the painter's experience. These factors include: atomizing, fluid pressures, and the necessity for thinning the paints. These factors are, in turn, influenced by:

(a) Paint viscosity.

(b) Ambient temperature during application.

(c) Type of spray equipment.

(d) Length and diameter of the paint lines.

(e) Height between paint pot and spray gun.

(4) Ensure that the spray equipment is clean, in good working order, and correctly assembled. Obviously worn parts, particularly the air cap, fluid tip, and needle, shall be replaced. These parts shall be examined for clogging and shall be cleaned during the application whenever it is apparent that the gun is spraying improperly.

(5) Vinyl Paint Thinner. Methyl isobutyl ketone, or a 50-50 mixture of methyl isobutyl ketone and xylene, should be used for thinning paints when required to obtain a suitable spray pattern or when cleaning the equipment. A mixture of 1/2 to 1 gallon of ketone to 5 gallons of paint has been found to thin most vinyl paints adequately.

(6) Vinyl Viscosity Reduction. The reduction of vinyl viscosity has been done by warming cans in a steam box located on the job, maintaining the temperature below 48.3°C (110°F). Formula 119 or Formula 120 that has gelled because of storage at low temperature can be restored by heating to a maximum of 48.9°C (120°F).

(7) Spray Gun Adjustments. For each application or new paint shipment, the spraying conditions may differ, requiring spray adjustments. Adjust the spray gun to wide fan position and the paint fluid valve to 1/2 the fully open position. Adjust the atomizing air on the gun to 60 pounds and the paint fluid pressure to 30 pounds and sample the spray pattern. If the spray pattern is not suitable, and no further adjustment or combination of adjustments of fan width and paint fluid valve will correct the pattern, increase the fluid paint pressure, in increments of 10 pounds, up to 60 pounds. If the spray pattern is still not suitable, the vinyl paints need to be thinned (paragraph (5) above).

(8) Adjust the spray gun pressure to obtain a uniform fan with proper atomization. A spray pattern that produces too dry a spray will result in a powdery surface with a considerable deposit of spray dust on it. To correct the dry spray, reduce the air pressure and increase the paint pressure. A fan pattern created by too wet a spray may result in a film that is splotchy or that sags. To correct the excessively wet spray, reduce the paint pressure and increase the air pressure. Spray pattern should be kept wet and the film continuous as the area is covered. If the fan narrows down or the paint starts to spit out of the gun, the nozzle should be removed and cleaned.

(9) Vinyl Spray Coating Techniques. Vinyl paint shall be applied with continuous parallel strokes overlapping the preceding stroke by at least 2 inches. The painter should not pause at the end of the stroke, because paint will pile up at the laps, resulting in an uneven appearance and sagging. The correct gun-to-surface distance should be maintained wherever practical and should not exceed 16 inches. A spray coat consists of the maximum amount of paint that can be applied at one time (in one or more passes) without sagging.

(10) Three-Pass Cross Technique. To produce uniform films of proper thickness, a three-pass cross technique has been found particularly suitable for vinyl primer application to large areas. Cover an area with horizontal spray gun passes, moving the gun at a speed that will keep the spray pattern wet and the film continuous as the area is covered. Next, cross the same area with vertical passes of the gun. Last, horizontally recross the area. Consider these three passes of the gun as one spray coat.

(11) Confined Area Techniques. In confined areas, such as crown frames and other welded structural members, it is usually not practical to cross-stroke each spray pass. In such areas, the spray passes should be made back and forth in the same direction and the painter should reduce the middle of the spray pattern to fit the structural member. To cover tight corners and weld areas, the pattern should be reduced to a small oval.

# SECTION 7 SHIPBOARD PAINT APPLICATION

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**7-1. General.** This section covers the application of paints to shipboard equipment, bilges, tanks, and interior and exterior surfaces of US Army vessels.

**7-2. Pretreating, Priming, and Insulating Metal Surfaces.** Metal surfaces should be pretreated and primed as soon as practical after surface preparation. This prevents corrosion and maintains the state of preservation until the finish coat can be applied. To prevent bimetallic corrosion, dissimilar metal surfaces must be insulated from each other. The preservation of metal surfaces is described below.

a. Steel Surfaces. Except when otherwise specified, steel should be painted with at least one coat as soon as practical after surface preparation and pretreatment (when the latter is specified). See painting instructions pertaining to the end use of the steel to determine the proper primer for final painting.

(1) Pretreatment Formula 117. For paint systems requiring pretreatment, primer should not be applied prior to application of Formula 117. In interior locations where necessary, safety precautions normally are not practical, Formula 117 may be omitted except under vinyl paints. Formula 117 may also be omitted (except under vinyl paints) for painting done by ship's force.

(2) Primer Coats. Apply one priming coat to interior surfaces. Apply a complete second coat of primer to exterior surfaces. Formula 84D can be used over Formula 84 to provide color contrast between coats. Give all edges, welding, rivet heads, and other protruding objects an additional coat of primer. Clean and touch up areas that become bare or show rust; use one coat of primer on interior surfaces and two coats on exterior surfaces.

b. Galvanized Steel.

(1) Paint all galvanized steel unless painting is specifically excluded elsewhere in this TB. Apply epoxy paints where specified; otherwise, apply one coat of Formula 117 and one coat of Formula 84 to surfaces that are to be painted. Use Formula 120 instead of Formula 84 where a vinyl system is specified.

(2) Paint welds and damaged areas of galvanized surfaces as required for the surrounding galvanized area. Apply paint only to surfaces that have been cleaned (preferably by abrasive blasting). Where painting is not required, apply one of the following coatings to welds and damaged areas:

(a) Two coats to galvanizing repair paint (MIL-P-20135).

(b) Two coats of zinc dust paint (MIL-E-15145, Formula 102).

c. Aluminum Surfaces. Paint bare aluminum surfaces as soon as pratical to prevent corrosion. The ship's force should make frequent inspections of aluminum structure and fastenings to determine condition of the aluminum surfaces.

(1) Aluminum Pretreatment. Pretreatment requirements for exterior aluminum surfaces are specified in Appendix B. Except for tanks, bilges, and voids, coat interior surfaces that are to be painted with one coat of Formula 84 or 84D.

(2) Faying Surfaces. As described in paragraph (1) above and Appendix B, paint faying and aluminum surfaces that are in contact with aluminum or joined to other metal or wood. Coat wood in contact with aluminum with one coat of spar varnish, Fed Spec TT-V-119.

(a) Aluminum faying surfaces in contact with other metals that require sealing from moisture shall be treated as specified for faying surfaces. All joints shall be sealed with calking compound MIL-C-18969. For watertightness, horizontal joints exposed to the weather shall be sealed with calking compound. This is not required where butyl or neoprene rubber tape has been used.

(b) Insulation tape must be installed between faying surfaces where one or both sides of a joint are exposed to seawater, weather, or dampness. Tape shall be at least 17 mils thick (two layers of MIL-E-24391 tape) and be of sufficient width to extend beyond the joint edge. Pressure-sensitive tape may be difficult to apply where insulating material must be inserted after final drilling and cleaning of faying surfaces. Wetting pressure-sensitive tape with kerosene or dusting lightly with talc before installation usually facilitates installation.

d. Miscellaneous Metals.

(1) In interior compartments, corrosion-resisting steel, brass, nickel-copper alloy, and copper-nickel alloy are not required to be painted except to improve appearance. Where exterior areas are painted for camouflage, apply Formula 117 or Formula 150 prior to application of finish paint.

(2) In seawater tanks and fuel ballast tanks, completely paint corrosion-resistant steel (CRES) and copper alloy piping to minimize the effect of galvanic corrosion on the coated tank surfaces (paragraph 7-14.i.(1)).

Copper-bearing piping and components shall be painted only after adequate masking of rubber items, gaskets, filters, heat exchange surfaces, and critical sealing surfaces.

e. Dissimilar Metal Surfaces.

(1) The most effective methods for preventing bimetallic corrosion are careful design and correct assembly. Excellent workmanship is required to insulate dissimilar metals effectively. Properly applied films of specified paints and insulation tapes will increase durability and prevent corrosion.

(2) For insulation material to function effectively, it must be installed so that all joints are closed; this ensures that water cannot collect and form a bridge between steel and aluminum. For ships in service where no insulating tape appears to have been used, or where existing tape has deteriorated, horizontal joints exposed to the weather shall be sealed with calking compound.

**7-3. Non-Metallic Surfaces**. The painting and preservation of non-metallic surfaces such as wood, plastic, and rubber items are described below.

a. Wood Surfaces.

(1) Varnished Surfaces. Fill defects in wood that is to be varnished with wood filler, Fed Spec TT-F-336. Stain the wood to the desired shade with one of the following stains: Formula 49, 50, 51, 52, or 54. Coat the stained wood with three coats of varnish, Fed Spec TT-V-119.

(2) Painted Surfaces. In general, prime the wood with one coat of aluminum paint. Then apply finish paint (usually two coats). Prepare aluminum paint by mixing 2 pounds of aluminum paste, Fed Spec TT-P-320, Type II, Class 2, with 1 gallon of varnish, Fed Spec TT-V-199. Do not use aluminum paint on underwater surfaces or under vinyl paints.

(3) Underwater Surfaces. Treat the wood with wood preservative, then prime the wood with Formula 117. Treat chain lockers and bilges with a heavy coat of wood preservative, MIL-W-18142.

(4) Apply two coats of Formula 121 to outer surfaces of hull planking behind teredoprotective wood sheathing, and to inner surfaces and seams of the sheathing. Except for surfaces exposed to seawater, apply one coat of aluminum paint to all butted-end-joint faying surfaces before assembly and to the end grain of all members not otherwise specified to be calked or sealed.

b. Fibrous Glass Board. Coat fibrous glass board in interior compartments with chlorinated alkyd-base paint. Use one coat to finish, two if required for hiding.

c. Rubber Items. Rubber items (such as gaskets and expansion joint components) in contact with painted or cemented surfaces shall not be clamped in place under pressure until paints or cements in contact with the rubber have dried sufficiently. Allow painted surfaces to dry tack-free. Apply paint to rubber surfaces only when specified. Before putting rubber items in palce, allow solvent to evaporate from applied cement until surfaces are only slightly tacky. Allow an additional 3-hour drying period before applying pressure.

d. Plastic. Plastic surfaces that are to be painted shall be pretreated with a coat of Formula 117, or epoxy primer Formula 150. Plastic sonar domes, radomes, and special equipment shall be painted as specified in the applicable manual, drawing, or other document.

**7-4. Shipbottom Epoxy Anticorrosive Coatings.** Commercial epoxy anticorrosive coatings that have been approved for use on shipbottoms and are considered to be an acceptable alternative to MIL-P-24441, Navy formula epoxy coatings, for these applications only. These proprietary coatings are listed in Appendix A. Coating shall be applied as recommended by the manufacturer except for minimum film thickness.

a. Surface Preparation. Minimum surface preparation standards for MIL-P-24441 coatings, as stated in paragraph 6-2.d, shall be followed if they are more stringent than the manufacturer's instructions.

b. Final Coats. The antifouling topcoat for shipbottoms shall be either Formula 121 (red) or Formula 129 (black). Navy formula epoxy coatings MIL-P-24441 are compatible for use as either topcoats over proprietary epoxy paints or for paint touchup.

c. Approved Coatings from Proprietary Sources. Proprietary coatings are to be purchased on a competitive basis. Coating selection shall be made on the basis of factors which contribute to total application cost and time available for application. Paint thickness requirements specified in Appendix B shall be used for estimating total cost. The factors to be considered are:

(1) Total coating material cost (that is, cost per square foot for required total film thickness, rather than cost per gallon).

(2) Equipment available for coating application, and ease of application.

(3) Ambient temperature, pot life, stand-in or induction time, drying time required between coats, and curing time.

(4) Safety precautions required.

(5) Colors of coating system as an aid to application and inspection of the surface during application and in service.

(6) Availability of technical services.

(7) Procurement activities should solicit invitations for bid and comply with Defense Acquisition Regulations (DAR) on each requisision for proprietary coatings.

d. Aluminum Boats Shipbottom Paint System.

(1) Antifouling paint need not be applied to aluminum boats which are dry-berthed or subject to frequent beaching. The NMP has the responsibility for deciding whether to apply antifouling paint under these conditions.

(2) Commanders have the responsibility for specifying the desired antifouling paint colors for aluminum ships or crafts in their Commands, and for new aluminum ships or crafts scheduled to join their Commands.

(3) The proprietary products approved for use on underwater hull and aluminum boat boot-topping are listed in Appendix B.

**7-5. MIL-P-23236 Coating for Bilges and Tanks (Except Potable Water Tanks).** Paint coating systems that qualify under MIL-P-23236 and are listed in its Qualified Products List (QPL) are approved as coatings for tanks.

a. MIL-P-23236 Application. Surface preparation by abrasive blasting to near-white metal is required for maximum adhesion and performance. Coating shall be applied as recommended by the manufacturer, except that minimum DFT requirement shall be as shown in QPL-23236.

b. MIL-P-23236 Coating Limitations.

(1) The latest QPL-23236 shall be consulted for the four classes of specifically approved proprietary products. These classes are:

(a) Class 1 - epoxy

(b) Class 2 - coal tar epoxy

(c) Class 3 - inorganic zinc

(d) Class 4 - polyurethane

(2) Limitations applicable to the various coating classes in MIL-P-23236 are:

(a) Class 2 (coal tar epoxy) and Class 3 (inorganic zinc) coatings are not approved for fuel tanks. Coal tar epoxy may discolor fuel and inorganic zinc can lead to excessive suspended particles. Coal tar epoxy paints require special safety precautions (see Section 2).

(b) Class 3 (inorganic zinc) coatings shall not be used in an acid environment, such as in sanitary tanks, or where acid cleaning is used. In addition, seawater tanks shall not be coated with inorganic zinc coatings.

(c) Some Class 3 coatings (inorganic zinc) cannot be applied over any existing coatings (refer to the manufacturer's instructions).

(d) Class 4 (polyurethane) coatings require special safety precautions (see Section 2).

c. Touchup Painting. For touchup painting and recoating, the same brand of coating (within the specific class of MIL-P-23236 or MIL-P-24441 coatings) may be applied. Navy formula epoxy coatings in MIL-P-24441 are considered to be compatible topcoats for touchup painting and recoating over the four classes of coatings in MIL-P-23236.

7-6. **Potable Water Tank Coating Systems**. Excessively applied or inadequately cured potable (fresh) water tank coatings have a potential impact on crew health, well being and morale, because they make food and beverages unpalatable. Ship operating schedules can also be adversely affected, with worst cases requiring unanticipated additional time at an industrial activity for coating replacement. It is recommended that all potable water tanks be painted at each overhaul by a depot-level activity to maximize compliance with these procedures and to minimize the extent of potable water tank preservation required out of overhaul, when time allowed for paint curing may be marginal or inadequate.

a. Approved Coating Systems. Along with the Navy epoxy coating system and the zinc dust (Formula 102) paint system, the commercial products listed in table B-4 are approved for use in potable water tanks.

b. Preferred System. The MIL-P-24441 paint system provides the maximum preservation and blister resistance with the least solvent entrapment. Formula 152 an 156 may be used interchangeably.

c. Touch Up. Formula 102 shall be used to touch up tanks already coated with Formula 102. Touchup shall be as necessary to provide a total DFT of 4 mils minimum. For mixing of Formula 102, see MIL-E-15145. Application shall be brush or spray.

d. Proprietary Coatings. Proprietary coatings listed in Appendix A, Table A-3 shall be mixed and applied in accordance with the manufacturer's instructions and as specified in this TB. If ambiquity exists, requirements of the TB shall govern. Any unresolved conflicts shall be reported to the NMP for guidance.

e. Coating Requirements.

(1) The following requirements apply to all coatings used in potable water tanks:

(a) Drying time between coats shall be no less than 48 hours at a minimum temperature of 21°C (70°F). Heated air shall be used if necessary to maintain the proper temperature.

(b) Ventilation shall be a continuous airflow. (See Section 2).

(c) Fully coated tanks shall be cured for a minimum of 7 days under the same conditions prior to being filled.

(d) Refer to paragraph 2-12. Appliation of Paint in a Confined Space for ventilation requirements guidance.

(e) Freshly painted potable water tanks shall be rinsed at least twice with freshwater before being disinfected and put into service.

(2) It is recognized that situations arise where very limited touchup is required, and specified drying times have an adverse impact on ship schedule. There is no approved procedure for accelerating drying or curing of these paints. Any situations requiring accelerated paint drying or curing should be referred to the NMP for approval, including proposed resolution such as using heat to shorten drying and curing times.

f. Film Thickness Requirements.

(1) WFT to DFT thickness ratios should be locally determined for the selected coating. Use the same mixing and application procedures which will be used for ship tank painting. Painters should be instructed to apply paint within a WFT range that will result in the required DFT. All potable water tank painters should be supplied with WFT gages.

(2) Procedures shall be instituted to ensure that maximum per-coat film thickness of each approved paint system shall not exceed the maximum per-coat thickness, multiplied by the number of coats applied, for at least 98 percent of the tank surface area.

(3) Adequate painting for preservation may result in excessive thickness near angular shapes. In isolated areas, near stiffeners for example, the maximum DFT may be exceeded by up to 2 mils per coat, providing the total non-complying area is less than 2 percent of the tank surface. For touchup or overcoating intact aged paint in good condition, the same requirements apply. The total film thickness requirement may be corrected to allow for the thickness of underlying paint. The requirement is to avoid excess thickness in individual coats. High DFT resulting from properly applied extra coats is not considered to be a problem below 35 mils total.

g. Quality Assurance. Minimum quality assurance inspections for potable water tank coating shall include:

(1) Surface preparation (to ensure freedom from surface dirt, moisture, or other contaminants).

(2) DFT of any remaining aged coating.

(3) DFT after application of each coat, recording at least five measurements per 1,000 square feet of surface.

(4) Hardness of paint (to ensure that each coat has cured thoroughly).

## 7-7. Electric and Electronic Equipment.

a. Electric and electronic equipment will usually be supplied, painted, and preserved as required by either the individual purchase specifications or the operating manual. Painting and preservation may be necessary if the equipment is received in an unpainted condition or if the coating has been damaged before or during preservation. In addition, painting and preservation are necessary for finishing and installation.

b. Except as otherwise specified, the painting and preservation of electric and electronic equipment shall comprise:

(1) One coat of pretreatment (Formula 117) applied to bare metal surfaces only. Omit Formula 117 on ungalvanized surfaces in confined spaces where necessary safety precautions are not practical.

(2) One coat of primer (Formula 84). Use only Formula 84 over aluminum.

(3) Two coats of gray enamel (Formula 111 Class 2).

**7-8. Motors and Generators.** Motors and generators shall be painted in accordance with specifications given in the following:

a. Exterior Parts. Except for shafts and identification plates, paint exterior parts in accordance with paragraph 7-7.b above.

b. Interior Parts. Electrical insulation of all types, surfaces in contact with lubricating oil or grease, commutators, collector rings, brushes, bearings, and bearing surfaces shall not be painted. Do not paint peripheries of armatures and rotors or any other rotating part of a machine from which centrifugal force may cause the paint to be thrown on to the windings when the machine is operated at rated load and rated ambient temperature. Insulation varnish conforming to MIL-I-24092, instead of paint, may be applied to such parts. Paint other corrosion-resisting parts in accordance with paragraph 7-7.b. above.

c. Apply one coat of pretreatment (Formula 117) or primer (Formula 84), followed by one coat of white enamel (Fed Spec TT-E-489) to the inside of both ends of the enclosure of water- or air-cooled motors and generators.

d. To reduce wear of carbon brushes, paints which contain silicones resins, such as Fed Spec TT-P-29 and DOD-P-24555, shall not be used on, or in close proximity to, motors and generators.

**7-9. Switchboards and Panels.** Switchboards and dead-front type panels for control, power, lighting applications, and for electric propulsion, shall be given an additional finish coat only if cleaning and touchup will not give the desired result.

**7-10. Electric cables.** Do not paint electric cables.

**7-11. Metal Enclosures.**

a. Enclosures for motor controllers, electric panels, wiring boxes, fittings, fixtures and enclosures for electric equipment in general (except electronic, interior communication, and fire control equipment) for which painting is not otherwise specified in purchase specifications, shall be coated in accordance with Appendix B. For equipment received with pretreatment and primer only, apply finish coats as appropriate. Finish-paint matching the surrounding structure may be applied over Formula 111 to avoid masking enclosures when painting surrounding structure. Touch up any damaged coatings as required. Formula 117 pretreatment is not required over intact primer or in confined spaces where necessary safety precautions cannot be followed.

b. Brass, Corrosion Resistant Stainless (CRES), and nonferrous metals other than aluminum shall not be coated except where painting is desirable for appearance or camouflage.

**7-12. Miscellaneous Equipment.** The painting specifications for the miscellaneous shipboard equipment are given in Appendix B.

**7-13. Shipboard Items not to be Painted.** The following shipboard items are not to be painted:

a. CRES decks, CRES galley equipment, and CRES bulkheads in wet spaces.

b. Decorative plastic surfaces such as those on bulkheads and table tops.

c. Dogs (or operating gear) on watertight doors, hatches, scuttles, and similar items.

d. Hatch and door rubber gaskets, rubber window moldings.

e. Sight glasses, gage faces, and identification plates and other markings which, if painted, would be illegible.

f. Insulators.

g. Knife edges of watertight doors and hatches.

h. Porcelainized surfaces.

i. Threaded parts, such as adjusting threads and takeup threads which, if painted, would not function properly.

j. Anodes and cathodic protection.

k. The following interior aluminum surfaces:

(1) Bins, shelves, dressers, cabinets, battens, and fittings.

(2) Interior gratings, handrails, and floor plates.

(3) Internal ventilation duct surfaces.

l. Electrical outlets, terminals, activating mechanisms of electrical safety devices, and control switchboards on machinery elevators.

m. Bell pulls, sheaves, annunciator chains, and other mechanical communication devices.

n. Within magazines, dry sprinkling piping with holes drilled in the pipe top.

o. Exposed composistion metal part of any machinery.

p. Glads, stems, yokes, toggle gear, and all machined external valve parts.

q. Heat exchange surfaces of heating or cooling equipment.

r. Joint faces of gaskets and packing surfaces.

s. Lubricating gear, such as oil holes, oil or grease cups, and lubricators and surfaces in contact with lubricating oil.

t. Lubricating oil reservoirs.

u. Machined metal surfaces of reciprocating engines or pumps and oil-wetted surfaces of internal combustion engines.

v. Metal lagging.

x. Rods, gears, universal joints, and couplings of valve operating gear.

y. Expansion joints, nonferrous parts of pipe hangers, flexible hose connections, items particularly fabricated of rubber, and resilient elements of isolation mounts.

z. Springs.

aa. Strainers.

ab. Working surfces.

ac. Deck fitting and joiner hardware on plastic boats.

ad. Light-reflecting and light-transmitting surfaces of items such as light fixtures, ports, and windows.

## 7-14. Preservation and Coating for Interior and Exterior Surfaces.

a. Exterior Surfaces. Metal exterior surfaces of all surface ship are to be coated in accordance with the requirements in Appendix B. The inorganic zinc primers called out in Appendix B are:

(1) Post-Cure Type

(a) Cathacoat 300 - Celanese Coatings Company.

(b) Dimetcote No. 3 - Ameron Corrosion Division.

(c) Rust-Ban 191/195 - Exxon Chemical Company.

(d) Zincilate 1010 - Industrial Metal Protective Company.

(2) Self-Cure Type

(a) Carbozinc 11 HFP - Carboline Company.

(b) Galvosil 1570 - Hemple's Marine Paints.

(c) Metalhide 100 - Pittsburgh Plate Glass Company.

(d) Mobilizinc 7, Mobilizinc 13-F-12 or Uni-Pak (13-C-10) - Mobil Chemical Company.

(e) Rust-Ban 191 or Rust-Ban 188-Exxon Chemical Company.

(f) Zinc-ite B - Plas-Chem Corporation.

(g) Interzinc HF 2410/2411 or Interzinc 2410/2411 - International Paint Company, Inc.

(h) Quram 3365 WZ - Philadelphia Quartz Company.

(i) Zinc Prime 200 - Grow Chemical Company.

(j) BPS Vitazinc 2946 - Patterson-Sargent.

(k) Stancoat 711R - Standard Paint & Varnish Company.

(l) Farbozinc No. 76 and Farbozinc No. 114 - Farboil Company.

(m) Durazinc 500 - Southern Imperial Coatings Corporation.

(n) Pro-Zinc 202 - Proline Paint Company.

(o) Briner Five-65 - Briner paint Manufacturing Company.

(p) Phyllyzinc 1 - Philadelphia Resins Corporation.

(q) SA-13446/SA-13447 - Andrew Brown Company.

(r) Rel-Zinc No. 63 - (Gray/Green)-Reliance Universal, Inc.

(s) Zincguard No. 3 - Seaguard Corporation.

(t) Zinc-Lock 351 NF and Zinc-Lock 351 HF - Porter Paint Company.

(u) Ganicin 347-934: EID and Ganicin 347-Y-947 - DuPont de Nemours Company.

(v) Napko 5-Z (High Flash) - Napko Corporation.

(w) Ameron 2066 and Dimetcote SHF - Ameron Corporation.

(x) Zincguard No. 6 - Seaguard Corporation.

(y) Mo-Zinc No. 4 (Gray 28-DH-51) and Mo-Zinc No. 5 (Green 28-DH-52) - Mobile Paint Manufacturing Company, Inc.

(z) ByCo Zinc-Gard 102-SP - Bywater Coatings Company.

b. Interior Compartments. Interior painting (except in tanks, voids, and bilges) is not necessary when existing paints meet the requirements of this TB and can be cleaned to the satisfaction of the ship's Commanding Officer.

**WARNING**

**Use a minumum number of thin coats when painting for appearance instead of preservation. Even the specified MIL-E-17970 fire-retardant paint system can contribute to spread of flames under fire conditions when total DFT exceeds 5 mils.**

c. Interior Color Schemes. Commanders may specify uniform painting schemes. The choice of colors for living, messing, recreation, commissary, sanitary spaces, and adjacent passageways must be restricted to those specified for decks, bulkheads, and overheads in Appendix B.

d. Surface Preparation and Coatings. If the existing coatings show signifiant defects such as cracking, peeling, and flaking, the entire surface should be cleaned to bare metal and repainted, using the appropriate procedure.

**CAUTION**

**To minimize premature yellowing, chlorinated alkyd-base paints shall not be applied within 4 weeks after amine-cured epoxy paints have been applied. The vapor from the epoxies that come in contact with the chlorinated alkyd paints will cause yellowing. Amine-cured epoxy paints include some MIL-P-23236 tank and bilge coatings.**

(1) Apply one coat of Formula 84 (use only Formula 84 on aluminum). Use two finish-coats of chlorinated alkyd-base paint on bulkheads and overheads. Chlorinated alkyd-base paints are applied in the same ways as conventional alkyd-base paint.

(2) Apply one coat of Formula 84 (use only Formula 84 on aluminum) and two finish-coats on decks.

(3) Both sides of uninsulated fire zone bulkheads shall receive two coats of MIL-C-46081 to a minimum DFT of mils over properly prepared and primed surfaces. Formula 150 and MIL-P-23277 are acceptable primers.

(4) Apply one coat of Formula 150 and one coat of Formula 152 to wet spaces such as washrooms, water closets, bath and shower spaces, sculleries, and vegetable preparation spaces. Apply as specified in paragraph 6-2.a. through h. to achieve at least 5 mils DFT.

e. Bulkheads and Overheads.

(1) Use chlorinated alkyd-base paints for overheads and bulkheads of living, messing, and recreation spaces, and their connecting passageways. Paint fibrous glass board to match surrounding structure. Finish-paint all other compartments in accordance with Appendix B.

(2) Interior deck colors may be carried up onto the bulkhead adjacent to the deck to a height of approximately 6 inches. Paints listed in Appendix B may also be used for deck boaders in spaces where rugs are installed. Interiors of weather doors may be finish-painted to match the surrounding bulkhead.

f. Painting Behind Equipment. Before installation of front-serviced electronics equipment, the bulkhead and deck area should be painted with two coats of primer, Formula 84 (Formula 84 over aluminum) and finish-painted as per Table B-2.

g. Decks and Walking Surfaces. Decks for which coverings are specified require painting where the deck covering consists of false decking, gratings, rugs, or portable material. Do not paint surfaces of aluminum or CRES. Deck Plates in main and auxiliary machinery spaces shall be painted as per Table B-2.

h. Acoustical-Absorptive Treated Surfaces. Surfaces treated with acoustical absorptive material shall be painted with one coat of paint (unless two coats are required to achieve hiding) to match surrounding structure. The paint shall be sprayed in thin coats and care shall be taken to prevent the paint from bridging or sealing the perforations in the acoustical treatment.

i. Tanks, Bilges, and Voids. Tanks, bilges, and voids shall be painted in accordance with Appendix B.

(1) CRES, copper-nickel, monel, bronze, and other copper-bearing metals are frequently used for piping and for components placed in coated tanks. The metals act as strong cathodes in immersion conditions, causing galvanic corrosion to take place at gaps (holidays) in the painted tank surface (anode). Deep pits occur at paint holidays since small anodic steel surfaces are exposed to relatively large cathodes of corrosion-resistant bearing metal. To protect against galvanic corrosion in immersion conditions, both the pipes and the components should be completely coated with the specified tank or bilge coating system, except where prohibited.

(2) Proprietary approved coating shall be applied as recommended by the manufacturer or as stated in the paint specification. The minimum surface preparation standards for MIL-P-24441 coating shall govern when they conflict with less thorough requirements in the manufacturer's instructions (paragraph 7-4.c.(3)).

# APPENDIX A

## Paint Materials

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TABLE A-1 MATERIALS COVERED BY FORMULA DESIGNATIONS

| Formula No. | Coating | NSNs and Container Size | Specification |
|---|---|---|---|
| 5-0 | Gray no. 17 (ocean gray) | 8010-00-297-0580 (1 gal) | DOD-E-1265 |
| 6N35-2 | Blue Identification primer | No NSN available | MIL-P-24351 |
| 19 | Green deck | 8010-00-286-3985 (1 gal) | DOD-E-18214 |
| | | 8010-00-286-3986 (5 gal) | DOD-E-18214 |
| 20 | Exterior gray deck | 8010-00-286-9083 (5 gal) | DOD-E-699 |
| 20L | Interior gray deck | 8010-00-285-4870 (1 gal) | DOD-E-700 |
| | | 8010-00-285-4871 (5 gal) | DOD-E-700 |
| 23 | Red deck | 8010-00-292-1812 (1 gal) | DOD-E-18210 |
| | | 8010-00-292-1813 (1 gal) | DOD-E-18210 |
| 24 | Black deck | 8010-00-664-4743 (1 gal) | DOD-E-698 |
| | | 8010-00-285-4896 (5 gal) | DOD-E-698 |
| 30 | White enamel | 8010-00-286-7744 (1 gal) | DOD-E-1115 |
| | | 8010-00-286-7745 (5 gal) | DOD-E-1115 |

TABLE A-1 MATERIALS COVERED BY FORMULA DESIGNATIONS (CONTINUED)

| Formula No. | Coating | NSNs and Container Size | Specification |
|---|---|---|---|
| 34 | Antisweat binder | 8010-00-290-6646 (1 gal) | DOD-P-15144 |
| 38 | Black striping | 8010-00-527-2050 (1 gal) | TT-E-489, Class A |
| 39 | Green striping | 8010-00-298-2296 (1 gal) | TT-E-489, Class A |
| 40 | Red striping | 8010-00-616-7486 (1 gal) | EE-E-489, Class A |
| 41 | Brown striping | 8010-00-285-4907 (1 qt) | MIL-P-20090 |
| | | 8010-00-285-4908 (1 gal) | MIL-P-20090 |
| 42 | Yellow striping | 8010-00-286-7758 (1 qt) | TT-E-489, Class A |
| | | 8010-00-527-2045 (1 gal) | TT-E-489, Class A |
| 43 | Blue striping | 8010-00-853-1859 (1 gal) | TT-E-489, Class A |
| 49 | Cherry stain | 8010-00-165-4422 (1 qt) | TT-S-711 |
| 50 | Dark mahogany stain | 8010-00-281-2075 (1 gal) | TT-S-711 |
| 51 | Dark oak stain | 8010-00-281-2072 (1 gal) | TT-S-711 |
| 52 | Light oak stain | 8010-00-597-8226 (1 qt) | TT-S-711 |
| | | 8010-00-166-0746 (1 gal) | TT-S-711 |
| 54 | Walnut stain | 8010-00-597-8225 (1 gal) | TT-S-711 |
| 67 | Slate color putty | 8030-00-275-8097 (1 gal) | TT-P-791, Type 2 |
| 84/47 | Zinc chromate primer | 8010-00-161-7419 (1 gal) | TT-P-645 |
| | | 8010-00-165-8557 (5 gal) | TT-P-645 |

TABLE A-1 MATERIALS COVERED BY FORMULA DESIGNATIONS (CONTINUED)

| Formula No. | Coating | NSNs and Container Size | Specification |
|---|---|---|---|
| 84D/47 | Zinc chromate primer dark | 8010-00-169-7082 (1 gal) | TT-P-645 |
| | | 8010-00-169-7083 (5 gal) | TT-P-645 |
| 102 | Zinc dust paint | 8010-00-290-6645 (5 gal) | MIL-P-15145 |
| 104 | Dull black | 8010-00-286-7854 (1 gal) | DOD-P-15146 |
| | | 8010-00-285-8294 (5 gal) | DOD-P-15146 |
| 109 | Gray, No. 11 | 8010-00-285-8297 (5 gal) | DOD-P-15183 |
| 111 | Light gray enamel | 8010-00-285-4858 (1 qt) | MIL-E-15090 |
| | | 8010-00-285-4868 (1 gal) | MIL-E-15090 |
| | | 8010-00-285-4869 (5 gal) | MIL-E-15090 |
| 117 | Pretreatment primer | 8030-00-165-8577 (5 gal kit) | DOD-P-15328 |
| | | 8030-00-850-7076 (1 qt kit) | DOD-P-15328 |
| | | 8030-00-965-2436 (1 pt kit) | DOD-P-15328 |
| 120 | Vinyl zinc chromate | 8010-00-584-2953 (1 qt) | MIL-P-15930 |
| | | 8010-00-664-0018 (1 gal) | MIL-P-15930 |
| | | 8010-00-753-4714 (5 gal) | MIL-P-15930 |
| 121/63 | Antifouling, red (vinyl) | 8010-00-879-1103 (5 gal) | MIL-P-15931 |
| 122-Ro1.8 | Black enamel (vinyl) | 8010-00-871-3477 (5 gal) | MIL-E-24306 |
| 122-Ro3.6 | Dark gray enamel (vinyl) | 8010-00-866-8275 (5 gal) | MIL-E-24292 |
| 122-Ro6 | Gray enamel (vinyl) | 8010-00-998-4813 (5 gal) | MIL-E-24307 |

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TABLE A-1 MATERIALS COVERED BY FORMULA DESIGNATIONS (CONTINUED)

| Formula No. | Coating | NSNs and Container Size | Specification |
|---|---|---|---|
| 122-11 | No. 11 gray (vinyl) | 8010-00-285-7014 (5 gal) | MIL-P-15935 |
| 122-27 | No. 27, haze gray (vinyl alkyd) | 8010-00-912-9525 (1 gal) | MIL-E-15936 |
| | | 8010-00-634-7324 (5 gal) | MIL-E-15936 |
| 122-82 | White (vinyl alkyd) | 8010-00-290-7293 (1 gal) | MIL-E-16738 |
| | | 8010-00-286-9082 (5 gal) | MIL-E-16738 |
| 124/66 | White (chlorinated alkyd) | 8010-00-577-4738 (1 gal) | MIL-E-17970 |
| | | 8010-00-577-4739 (5 gal) | MIL-E-17970 |
| 125/66 | Pastel green (chlorinated alkyd) | 8010-00-577-4734 (1 gal) | MIL-E-17971 |
| | | 8010-00-577-4735 (5 gal) | MIL-E-17971 |
| 126/66 | Bulkhead gray (chlorinated alkyd) | 8010-00-577-4736 (1 gal) | MIL-E-17972 |
| | | 8010-00-577-4737 (5 gal) | MIL-E-17972 |
| 129/63 | Antifouling, black (vinyl) | 8010-00-753-4945 (1 gal) | MIL-P-15931 |
| | | 8010-00-290-4247 (5 gal) | MIL-P-15931 |
| 133 | Rubber tie coat | 8010-00-823-7910 (1 gal) | MIL-P-22298 |
| 134 | Rubber antifouling | 8010-00-823-7911 (1 gal) | MIL-P-22299 |
| 150 | Green primer | 8010-00-922-1154 (2 qt kit) | MIL-P-24441/1 |
| | | 8010-00-410-8452 (2 gal kit) | MIL-P-24441/1 |
| | | 8010-00-437-6757 (10 gal kit) | MIL-P-24441/1 |
| 151 | Haze gray topcoat | 8010-00-922-1155 (2 qt kit) | MIL-P-24441/2 |
| | | 8010-00-410-8458 (2 gal kit) | MIL-P-24441/2 |
| | | 8010-00-410-8460 (10 gal kit) | MIL-P-24441/2 |

TABLE A-1 MATERIALS COVERED BY FORMULA DESIGNATIONS (CONTINUED)

| Formula No. | Coating | NSNs and Container Size | Specification |
|---|---|---|---|
| 152 | White topcoat | 8010-00-410-8461 (2 gal kit) | MIL-P-24441/3 |
| | | 8010-00-421-2435 (10 gal kit) | MIL-P-24441/3 |
| 153 | Black, Ro1.8 topcoat | 8010-00-410-8463 (2 gal kit) | MIL-P-24441/4 |
| | | 8010-00-410-8464 (10 gal kit) | MIL-P-24441/4 |
| 154 | Dark gray, Ro3.6 topcoat | 8010-00-410-8465 (2 gal kit) | MIL-P-24441/5 |
| | | 8010-00-410-8467 (10 gal kit) | MIL-P-24441/5 |
| 155 | Dark gray, Ro6 topcoat | 8010-00-410-8469 (10 gal kit) | MIL-P-24441/6 |
| 156 | Red topcoat | 8010-00-410-8470 (2 gal kit) | MIL-P-24441/7 |
| | | 8010-00-410-8471 (10 gal kit) | MIL-P-24441/7 |

TABLE A-2  MATERIALS NOT COVERED BY FORMULA DESIGNATIONS

| Material | Specification | NSN |
|---|---|---|
| Aluminum paste | TT-P-320 Type II, Class B | 8010-00-247-4347 (1 lb)<br>8010-00-247-4348 (10 lb) |
| Antisweat compound | TT-C-492 | 8010-00-965-2507 (1 gal) |
| Asphalt varnish | TT-V-51 | 8010-00-160-5856 (5 gal) |
| Anchor chain paint, solvent type, gloss black | MIL-P-24380 | 8010-00-145-0332 (1 gal)<br>8010-00-145-0341 (5 gal) |
| Calking compound, knife or gun application (metal and wood) | TT-C-001796, Type 1 | 8030-00-160-6899 (½ pt)<br>8030-00-577-4740 (½ gal cart)<br>8030-00-243-0956 (1 gal) |
| Calking compound, knife and calking iron application (metal only) | TT-C-001796, Type 2 | 8030-00-753-4982 (RO)<br>8030-00-297-0600 (1 qt) |
| Camouflage enamel, | MIL-E-5556 | |
| Brown (color 30279) | | 8010-00-597-7841 (1 gal) |
| Green (color 34424) | | 8010-00-597-7857 (5 gal) |
| Red (color 31136) | | 8010-00-597-7847 (1 gal) |
| Canvas preservative, | TT-P-595 | |
| Haze gray | | 8030-00-550-5906 (1 gal) |
| Deck gray | | 8030-00-281-2347 (1 gal) |
| Olive drab | | 8030-00-281-2346 (5 gal) |
| White | | 8030-00-550-8017 (1 gal) |
| Cleaning compound, solvent emulsion cleaner | MIL-C-22230 | 6850-00-292-9700 (5 gal)<br>6850-00-292-9701 (55 gal) |
| Cleaning compound, steam | P-C-437 | 6850-00-256-0157 (125 lb) |
| Coating epoxy | MIL-C-22750 | 8010-00-959-4661 (1 kit) |
| Coating bituminous | MIL-C-450 Type 2 | 8030-00-290-5141 (1 gal) |
| Corrosion preventive compounds: | | |
| Flotation type for seawater ballast tanks | MIL-R-21006 | 8030-00-543-7724 (55 gal) |

TABLE A-2 MATERIALS NOT COVERED BY FORMULA DESIGNATIONS (continued)

| Material | Specification | NSN |
|---|---|---|
| Solvent cutback, cold application, thin film | MIL-C-16173 Grade 1 (hard film) | 8030-00-231-2345 (1 gal)<br>8030-00-244-1299 (5 gal)<br>8030-00-244-1300 (55 gal) |
| | Grade 2 (soft film) | 8030-00-244-1297 (1 gal)<br>8030-00-244-1298 (5 gal)<br>8030-00-244-1295 (55 gal) |
| | Grade 3 (soft film, water displacing) | 8030-00-244-1296 (1 gal)<br>8030-00-244-1293 (5 gal)<br>8030-00-244-1294 (55 gal) |
| | Grade 4 (transparent, non-tacky film) | 8030-00-526-1605 (5 gal)<br>8030-00-526-1604 (55 gal) |
| Petrolatum, hot application | MIL-C-11796: Class 1 (hard film) | 8030-00-231-2354 (5 lb)<br>8030-00-597-3288 (35 lb) |
| | Class 1A (hard film, non-stick) | 8030-00-514-1843 (400 lb) |
| Corrosion preventive oil, nonstaining | MIL-C-22235, Type A | 8030-00-255-4447 (5 gal) |
| Deck covering compound, non-slip | MIL-D-23003, Type III (two part) | |
| Dark gray (color 36076) | | 5610-00-857-2452 (1 gal kit) |
| Haze gray (color 36270) | | 5610-00-857-4392 (1 gal kit)<br>5610-00-857-4393 (5 gal kit) |
| Red (color 31136) | | 5610-00-857-2451 (1 gal kit) |
| White, 55% min, reflectance | | 5610-00-857-2450 (1 gal kit) |
| Yellow (color 33538) | | 5610-00-857-4391 (1 gal kit) |
| Dark gray | MIL-D-24483, Type II (two part, carrier landing area) | 5610-00-516-0038 (5 gal kit) |
| Detergent, general purpose, water soluble | MIL-D-16791, Type I | 7930-00-282-9699 (1 gal)<br>7930-00-985-6911 (5 gal) |
| Diammonium phosphate | Tech. Grade | 6810-00-174-1821 (100 lb) |

TABLE A-2 MATERIALS NOT COVERED BY FORMULA DESIGNATIONS (continued)

| Material | Specification | NSN |
|---|---|---|
| Enamel (gloss) | TT-E-489, Class A<br>STD-595 Color no.: | |
| White | 17886 | 8010-00-664-4761 (1 gal) |
| Dark blue | 15044 | 8010-00-298-2302 (1 qt) |
| Light gray | 16376 | 8010-00-298-2290 (1 gal) |
| Dark gray | 16081 | 8010-00-297-2092 (1 qt) |
| Dark green | 14062 | 8010-00-779-9598 (1 qt) |
| Yellow | 13538 | 8010-00-286-7758 (1 qt) |
| Red | 11105 | 8010-00-527-2045 (1 gal)<br>8010-00-899-2345 (qt) |
| Orange | 12246 | 8010-00-616-7486 (1 gal)<br>8010-01-040-3762 (qt) |
| Black | 17038 | 8010-00-527-3201 (1 gal)<br>8010-00-527-2050 (1 gal) |
| Medium green | 14110 | 8010-00-286-7725 (5 gal)<br>8010-00-286-7727 (1 gal) |
| Clear blue | 15177 | 8010-00-577-4225 (1 gal) |
| International orange | 12197 | 8010-00-616-7492 (5 gal)<br>8010-00-527-3200 (1 gal) |
| Olive drab | 14087 | 8010-00-616-7495 (5 gal)<br>8010-00-298-2292 (1 gal) |
| High-light buff | 13578 | 8010-00-297-2005 (5 gal)<br>8010-00-584-3081 (1 gal) |
| White | 17875 | 8010-00-584-3082 (5 gal)<br>8010-00-664-4761 (1 gal)<br>8010-00-286-9088 (5 gal) |
| Enamel, silicone alkyd copolymer (semigloss White (color 27886) | TT-E-490 | 8010-00-145-0164 (1 gal)<br>8010-00-145-0165 (5 gal) |
| Haze gray (color) | | 8010-00-917-2256 (5 gal) |
| Epoxy polyamide, stontium chromate primer | MIL-P-23377 | 8010-00-082-2450 (2 gal kit)<br>8010-00-082-2477 (10 gal kit) |
| Epoxy polyamide, clear topcoat for weapons | MIL-C-22750 | 8010-00-896-1980 (2 gal kit) |
| Japan Drier | TT-D-651, Type I | 8010-00-165-4784 (1 gal) |
| Linseed oil (raw) | TT-L-215 | 8010-00-656-1639 (5 gal) |
| Oakum, marine | T-O-56, Class 1 | 5330-00-191-5679 (50 ft/lb) |

TABLE A-2 MATERIALS NOT COVERED BY FORMULA DESIGNATIONS (continued)

| Material | Specification | NSN |
|---|---|---|
| Packing material | HH-P-118 | 5330-00-171-6560 (coil) |
| Paint drier | TT-D-643 | |
| Cobalt base | | 8010-00-165-4782 (1 gal) |
| Paint, heat resisting (Use DOD-P-24555 whenever it is available) | TT-P-28 | 8010-00-664-7468 (1 qt)<br>8010-00-815-2692 (1 gal)<br>8010-00-857-1938 (5 gal) |
| Paint and varnish remover | TT-R-251, Type III | |
| For horizontal surfaces | Class A, low viscosity | 8010-00-597-8234 (1 gal)<br>8010-00-165-4447 (5 gal) |
| For vertical surfaces | Class B, high viscosity | 8010-00-160-5800 (1 gal)<br>8010-00-286-2861 (5 gal) |
| Plastic coating, sea rescue (orange color 12197) | MIL-C-15275 | 8030-00-281-2721 (5 gal) |
| Primer, zinc chromate, quick-drying | TT-P-664 | |
| | Composition G (general use) | 8010-00-292-1127 (1 gal) |
| | Composition L (limited use: mandatory for use where air pollution control laws are in effect, optional alternative to composition G in other areas) | 8010-00-161-7275 (5 gal) |
| Primer, zinc chromate, for aircraft | TT-P-1757 | |
| Green (color 34151) | | 8010-00-582-5318 (1 gal) |
| Yellow | | 8010-00-515-2208 (1 gal)<br>8010-00-515-2211 (5 gal) |
| Repair kit, glass reinforced plastic laminate | MIL-R-19907 | 2040-00-372-6064 |
| Rubber preservative | MIL-C-11520 | |
| Black | | 8030-00-201-1103 (1 gal) |
| Olive drab | | 8030-00-656-1030 (5 gal) |
| Sealing compound, wood bedding | MIL-S-19653<br>Type 1 (use without fabric) | 8030-00-579-8890 (1 gal) |
| Sodium hydroxide | O-S-598, Type 1 | 6810-00-174-6581 (100 lb) |
| Solvents: | | |
| Butyl alcohol | TT-B-846 | 6810-00-281-2685 (5 gal) |

TABLE A-2 MATERIALS NOT COVERED BY FORMULA DESIGNATIONS (continued)

| Material | Specification | NSN |
|---|---|---|
| Ethylene glycol monoethyl ether (EGM ether) | TT-E-781 | 6810-00-285-4309 (1 gal) |
| Lacquer thinner | TT-T-266 | 8010-00-160-5787 (1 gal)<br>8010-00-160-5788 (5 gal)<br>8010-00-160-5789 (55 gal) |
| Solvents: | | |
| Methyl isobutyl ketone | TT-M-268 | 6810-00-180-5976 (5 gal)<br>6810-00-281-2761 (55 gal) |
| Mineral spirits | TT-T-1291, Grade 1 | 8010-00-558-7026 (5 gal) |
| Synthetic enamel thinner | TT-T-306 | 8010-00-160-5794 (1 gal) |
| Xylene | TT-X-916 | 6810-00-290-4166 (55 gal) |
| Stencil paint, black | TT-P-98 | 8010-00-290-4135 (5 gal) |
| Tinting colors for white chlorinate alkyd, F-126/66 | DOD-C-22325<br>Paints made with these tints have FED-STD-595 Color Numbers as follows: | |
| Beach sand | 22563 | 8010-00-577-4929 (½ pint) |
| Rosewood | 22519 | 8010-00-577-4928 (½ pint) |
| Sunglow | 23697 | 8020-00-577-4932 (½ pint) |
| Clipper blue | 24516 | 8010-00-577-4933 (½ pint) |
| Varnish, spar | TT-V-119 | 8010-00-597-7856 (1 gal)<br>8010-00-251-6980 (5 gal) |
| Wood preservative, soluble | MIL-W-18142 | |
| Copper naphthanate | Type A | 8030-00-281-2724 (55 gal) |
| Chlorinated phenol | Type B | 8030-00-281-2717 (5 gal)<br>8030-00-281-2718 (55 gal) |
| Zinc yellow primer | TT-P-1757 | 8010-00-515-2208 (1 gal)<br>8010-00-515-2211 (5 gal) |

TABLE A-3 SHIPBOTTOM COMMERCIAL EPOXY ANTICORROSIVE COATING

| Source of Anticorrosive System | Coatings | Minimum DFT (mils) |
|---|---|---|
| Ameron Corrosion Control Division | 1 coat AMERCOAT 83 | 2 |
| | 1 coat AMERCOAT 84 | 6 |
| Devoe Marine Division | 3 coats DEVRAN 201 | 8 |
| | or | |
| | 1 coat DEVRAN 201 | 2 |
| | 1 coat DEVRAN 230 | 6 |
| International Paint Co. | 1 coat INTERGARD 4400/4414 | |
| | 1 coat INTERGARD 4404/4414 | |
| | 1 coat INTERGARD 4403/4414 | Total of 8 |
| | or | |
| | 1 coat INTERGARD 4400/4414 | 4 |
| | 1 coat INTERGARD 4413/4414 | 4 |
| Mobil Chemical Co. | 1 coat MOBIL 65-R-10 | 4 |
| | 1 coat MOBIL 65-E-15,<br>or 65-W-201,<br>or 65-F-201,<br>or 65-F-202,<br>or 65-F-203,<br>or 65-J-201 | 4 |

TABLE A-4 SOLVENT FLASHPOINTS

| Solvent | Flashpoint (closed up) |
|---|---|
| Acetone | -17.8°C (0°F) |
| Amyl acetate | 28.9°C (84°F) |
| Butyl acetate | 28.9°C (84°F) |
| n-Butyl alcohol | 35.0°C (95°F) |
| Butyl carbitol (diethylene glycol monobutyl ether) | 101.0°C (214°F) |
| Butyl cellosolve (ethylene glycol monobutyl ether) | 60.0°C (140°F) |
| Carbitol (diethylene glycol monoethyl ether) | 95.5°C (204°F) |
| Cellosolve (ethylene glycol monoethyl ether) | 42.0°C (108°F) |
| Cellosolve acetate (ethylene glycol monoethyl ether acetate) | 51.1°C (124°F) |
| Cyclohexanone | 43.9°C (111°F) |
| Diacetone alcohol | 47.2°C (117°F) |
| Ethyl acetate | -4.4°C (24°F) |
| Ethyl alcohol | 12.8°C (55°F) |
| High-flash naphtha | 43.3°C (110°F) |
| Isobutyl acetate | 17.8°C (64°F) |
| Isobutyl alcohol | 27.8°C (82°F) |
| Isophorone | 81.7°C (179°F) |
| Isopropyl alcohol | 11.7°C (53°F) |
| Methyl n-butyl ketone | 22.8°C (73°F) |
| Methyl cellosolve (ethylene glycol monomethyl ether) | 41.7°C (107°F) |
| Methyl cellosolve acetate (ethylene glycol monomethyl ether acetate) | 49.4°C (121°F) |
| Methyl ethyl ketone | -1.1°C (30°F) |
| Methyl isobutyl ketone | 15.6°C (60°F) |
| Mineral spirits (paint thinner) | 42.8°C (109°F) |

TABLE A-4 SOLVENT FLASHPOINTS (CONTINUED)

| Solvent | Flashpoint (closed up) |
|---|---|
| SOLVATONE solvent M | 25.6°C (78°F) |
| Dry cleaning solvent, type II | 58.9°C (138°F) |
| Styrene | 32.2°C (90°F) |
| Toluene | 4.4°C (40°F) |
| Turpentine | 35.0°C (95°F) |
| VM&P naphtha | -6.6°C (20°F) |
| Xylene | 17.2°C (63°F) |

TABLE A-5 MIL-P-24441 JOB SITE AMBIENT TEMPERATURE AND INDUCTION TIME

| Ambient Temperature °C (°F) | Induction Time (in hours) |
|---|---|
| 1.6 to 10 (35 to 50) | 2 at 21.1°C (70°F) |
| 10.0 to 15.6 (50 to 60) | 2 |
| 15.6 to 21.1 (60 to 70) | 1 to 1-½ |
| 21.1 and above (70 and above) | ½ to 1 |

## APPENDIX B

## Painting Systems

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### TABLE B-1 PAINTING SYSTEM FOR EXTERIOR SURFACES

**NOTE**

Paint System 1 is the preferred system for watercraft. When Paint System 1 is used it is Not necessary to abrasive blast to bare metal at each drydocking, sweep blast to remove loose paint and recoat. Reference Section 3.

| | Peacetime and Mobilization | | Finish Paint | |
|---|---|---|---|---|
| Area | Preprimer | Primer | Peacetime | Mobilization |
| Hull, all surfaces and appendages extending below underside of bulwark cap or main deck level. | | | | |
| 1. Bottom of all steel hull vessels. Underwater areas from lower limit of boot top or light load line to and including entire bottom, appendages, strainer plates, and sea chest: | | | | |
| Paint System I | None | 1 coat formula 150,<br>1 coat formula 151 or 150,<br>1 coat formula 154 or 150,<br>(Total 3 coats) MIL-P-24441 | 2 coats formula 121/63 MIL-P15931 | 2 coats formula 121/63 MIL-P-15931 |
| Paint System II | 1 coat formula 117 | 1 coat formula 14N, 1 coat formula 14ND, 1 coat formula 14N, MIL-P-19453, Total 3 coats for minimum 4-5 Mils. | 3 coats formula 105, MIL-P-19451, minimum 10 Mils. | 3 coats formula 105 MIL-P-19451 Minimum 10 Mils |

TABLE B-1 PAINTING SYSTEM FOR EXTERIOR SURFACES (CONTINUED)

CAUTION

Inorganic Zinc is NOT to be used on boot top and underwater area.

| Area | Peacetime and Mobilization | | Finish Paint | |
|---|---|---|---|---|
| | Preprimer | Primer | Peacetime | Mobilization |
| 2. Boot top area. From six (6) inches below light load line to six (6) inches above deep load line for ship formed hulls. Vessels with constant draft, boot top shall be from six (6) inches below to eighteen (18) inches above line of flotation. However, no boot topping will be applied to Landing Craft (LCM's). Bottom paint will be applied up to light loadline. | | | | |
| Paint System I | None | 1 coat formula 150<br>1 coat formula 151 or 150<br>1 coat formula 154 or 150 (Total 3 coats) MIL-P 24441 | 2 coats formula 129/63 MIL-P-15931 | 2 coats formula 129/63 MIL-P-15931 |
| Paint System II | 1 coat formula 117 | 1 coat formula 14N, 1 coat formula 14ND, 1 coat formula 14N, MIL-P-19453, Total 3 coats for minimum 4-5 Mils. | 3 coats formula 105, MIL-P-19451, minimum 10 Mils. | 3 coats formula 105 MIL-P-19451 Minimum 10 Mils |
| 3. Top Sides. Hull area from upper limits of boot top area or light load line to bulwark cap or main deck level. | | | | |
| a. Steel Hull Tugs. | | | | |
| Paint System I | None | 1 coat Inorganic Zinc, MIL-P-23236 Class 3.<br>1 coat formula 150<br>1 coat formula 150 or 151 MIL-P-24441 (Total 2 coats) | 2 coats TT-E-489, (color 17038) Black | 2 Coats TT-E-490, (color 26270) Haze Gray |

TABLE B-1 PAINTING SYSTEM FOR EXTERIOR SURFACES (CONTINUED)

| | Peacetime and Mobilization | | Finish Paint | |
|---|---|---|---|---|
| Area | Preprimer | Primer | Peacetime | Mobilization |
| Paint System II | None | 1 coat formula 150<br>1 coat formula 151 or 150 | 2 coats, TT-E-489, (color 17038) Black | 2 coats, TT-E-490, (color 26270) Haze Gray |
| b. All other Steel Hulls. | | | | |
| Paint System I | None | 1 coat Inorganic Zinc, MIL-P-23236, Class 3<br>1 coat formula 150<br>1 coat formula 151 or 150 (Total 2 coats) MIL P-24441 | 2 coats TT-E-490 (color 26270) Haze Gray | 2 coats TT-E 490 (color 26270) Haze Gray |
| Paint System II | None | 1 coat formula 150<br>1 coat formula 151 or 150 | 2 coats TT-E-490 (color 26270) Haze Gray | 2 coats TT-E 490 (color 26270) Haze Gray |
| 4. Deck and other exterior horizontal surfaces and up nine (9) inches on super structure including hatch covers. | | | | |
| Steel surfaces. | | | | |
| Paint System I | None | 1 coat Inorganic Zinc, MIL-P-23236 Class 3<br>1 coat formula 150<br>1 coat formula 151, MIL-P-24441 | 2 coats formula 20, DOD-E-699 | 2 coats formula 20, DOD-E-699 |
| Paint System II | None | 1 coat formula 150<br>1 coat formula 151, MIL-P 24441 | 2 coats formula 20, DOD-E-699 | 2 coats formula 20, DOD-E-699 |

**NOTE**

Paint System I is the preferred system for top sides.

TABLE B-1 PAINTING SYSTEM FOR EXTERIOR SURFACES (CONTINUED)

| | Peacetime and Mobilization | | Finish Paint | |
|---|---|---|---|---|
| Area | Preprimer | Primer | Peacetime | Mobilization |
| 5. Superstructure surfaces. | | | | |
| a. All steel hulls except non-self propelled vessels and landing craft. | | | | |
| From nine (9) inches above deck. | | | | |
| Paint System I | None | 1 coat Inorganic Zinc, MIL-P-23236 Class 3<br>1 mist coat of formula 150<br>1 coat formula 151 or 150 MIL-P-24441 | 2 coats TT-E-490 (color 27886) white | 2 coats TT-E-490 (color 26270) Haze Gray |
| Paint System II | None | 1 coat formula 150<br>1 coat formula 150 or 151 | 2 coats TT-E-490 (color 27886) white | 2 coats TT-E-490 (color 26270) Haze |
| b. All non-self propelled vessels and landing craft. | | | | |
| Paint System I | None | 1 coat Inorganic Zinc, MIL-P-23236 Class 3<br>1 mist coat of formula 150<br>1 coat formula 150 or 151, MIL-P-24441 | 2 coats TT-E-490 (color 26270) Haze Gray | 2 coats TT-E-490 (color 26270) Haze Gray |
| Paint System II | None | 1 coat formula 150<br>1 coat formula 151 or 150 MIL-P-24441 | 2 coats TT-E-490 (color 26270) Haze Gray | 2 coats TT-E-490 (color 26270) Haze Gray |
| 6. Visor or pilothouse, underside. | | | | |
| Paint System I or II | SAME AS ITEM 5a ABOVE | | 2 coats formula 39, TT-E-489 Class A Green | 2 coats formula 39, TT-E-489 Class A Green |

TABLE B-1 PAINTING SYSTEM FOR EXTERIOR SURFACES (CONTINUED)

|  | Peacetime and Mobilization |  | Finish Paint |  |
|---|---|---|---|---|
| Area | Preprimer | Primer | Peacetime | Mobilization |
| 7. Stack. |  |  |  |  |
| Paint System I | None | 1 coat Inorganic Zinc, MIL-P-23236 Class 3<br>1 mist coat of formula 150 | 2 coats TT-E-489 (color 13578) Highlight buff. | 2 coats TT-E-490 (color 26270) Haze Gray |
| Stack bands as shown on figures 1 & 2, Appendix D. |  | 1 coat formula 150, MIL-P 24441 | 2 coats formula 40 (red)<br>2 coats Formula 30 (white) | 2 coats DOD-P-24555 Black |
|  |  |  | 2 coats formula 43 (Blue)<br>2 coats DOD-P-24555 (Black)<br>figure 1 | figure 2 |
| Paint System II | None | 1 coat formula 150<br>1 coat formula 151 or 150<br>MIL-P-24441 | SAME AS ABOVE | SAME AS ABOVE |
| 8. Anchor and chain. |  |  |  |  |
| Paint System I | None | 1 coat formula 150<br>1 coat formula 151<br>MIL-P-24441 | 1 coat formula 153, Black MIL-P-24441 | 1 coat formula 153, Black MIL-P-24441 |
| Paint System II | None | 1 coat TT-V-51 | 1 coat MIL-P-24380, Black | 1 coat MIL-P-24380, Black |
| 9. Lighter Amphibian Resupply Cargo (LARC) Exterior hull, main deck, operator cab and cargo well deck. |  |  |  |  |
| Paint System I | None | 1 coat Inorganic Zinc, MIL-P-23236<br>1 mist coat of formula 150<br>1 coat formula 150, MIL-P-24441 | 2 coats TT-E 489 Olive Drab | 2 coats TT-E 489 Olive Drab |
| 10. Lighter Air Cushion Vehicle (LACV-30). | Painting will be in accordance with Final Draft of 7467-954002-12 manual. |  |  |  |

TABLE B-2 PAINTING SYSTEM FOR INTERIOR SURFACES

| | | Peacetime and Mobilization | |
|---|---|---|---|
| Area | Preprimer | Primer | Finish Paint |
| 1. Battery room and/or compartment. | | | |
| a. Deck | None | Zinc chromate Primer, TT-P-645, Formula 84/47 | Interior gray DOD-E-700, Formula 20L |
| b. Bulkhead and overhead | None | Zinc chromate primer, TT-P-645, Formula 84/47 | White (chlorinated alkyd), MIL-E-17970, Formula 124/66 |
| 2. Berthing spaces. | | | |
| a. Deck | None | Zinc chromate primer, TT-P-645, Formula 84/47 | Green deck, DOD-E-18214, Formula 19 |
| b. Bulkhead and overhead | None | Zinc chromate primer, TT-P-645, Formula 84/47 | Pastel green (chlorinated alkyd)MIL-E-17971, Formula 125/66 |
| 3. Crew messing space and galley. | | | |
| a. Deck | None | Zinc chromate Primer, TT-P-645, Formula 84/47 | Green deck, DOD-E-18214 Formula 19 |
| b. Bulkhead and overhead | None | Zinc chromate primer, TT-P-645, Formula 84/47 | White (chlorinated alkyd) MIL-E-17970, Formula 124/66 |
| 4. Dry cargo compartment. | | | |
| Deck, bulkhead, and overhead | None | Zinc chromate primer, TT-P-645, Formula 84/47 | Interior deck gray, DOD-E-700, Formula 20L |

TABLE B-2 PAINTING SYSTEM FOR INTERIOR SURFACES (CONTINUED)

| | Peacetime and Mobilization | | |
|---|---|---|---|
| Area | Preprimer | Primer | Finish Paint |
| 5. Machinery spaces. | | | |
| a. Bulkhead and overhead | None | Zinc chromate primer, TT-P-645, Formula 84/47 | White (chlorinated alkyd) MIL-E-17970, Formula 124/66 |
| b. Entire bilge area, steel deck plates and from deck plates up the bulkhead 12 inches. | | | |
| Paint System I | None | 1 coat Formula 150, 1 coat Formula 151 or 156 | Red top coat MIL-P-24441/7 Formula 156 |
| Paint System II | None | 2 coats Formula 84/47 | Red Deck DOD-E-18210 Formula 23 |

**NOTE**

Paint System II shall be utilized for touchup on areas presently coated with red lead primer formula 116 or 116D.

| | | | |
|---|---|---|---|
| 6. Officers stateroom and messroom. | | | |
| a. Deck and up bulkhead 9 inches. | None | Zinc chromate primer, TT-P-645, Formula 84/47 | Green deck, DOD-E-18214 Formula 19 |
| b. Bulkhead and overhead. | None | Zinc chromate primer, TT-P-645, Formula 84/47 | Pastel green (chlorinated alkyd) MIL-E-17971, Formula 125/66 |
| 7. Passageways. | | | |
| a. Deck and up bulkhead 9 inches. | None | Zinc chromate primer, TT-P-645, Formula 84/47 | Green deck, DOD-E-18214, Formula 19 |
| b. Bulkhead and overhead. | None | Zinc chromate primer, TT-P-645, Formula 84/47 | White (chlorinated alkyd) MIL-E-17970, Formula 124/66 |

TABLE B-2 PAINTING SYSTEM FOR INTERIOR SURFACES (CONTINUED)

| | | Peacetime and Mobilization | |
|---|---|---|---|
| Area | Preprimer | Primer | Finish Paint |
| 8. Refrigerated spaces. | | | |
| a. Natural wood | None | Phenolic primer, MIL-P-12742, Type II | None |
| b. Ferrous metal | None | Phenolic primer, MIL-P-12742, Type I | |
| 9. Workshop, storeroom, washrooms, and water closet spaces. | | | |
| a. Deck | None | Zinc chromate primer, TT-P-645, formula 84/47 | Green deck, DOD-E-18214, Formula 19 |
| b. Bulkhead and overhead. | None | Zinc chromate primer, TT-P-645, Formula 84/47 | White (chlorinated alkyd) MIL-E-17970, Formula 124/66 |

## TABLE B-3 FINISH PAINT FOR MISCELLANEOUS EQUIPMENT

| AREA | PEACETIME | MOBILIZATION |
|---|---|---|
| 1. Airports and deadlight frames | Same as adjacent surfaces | Same as adjacent surfaces |
| 2. Battery boxes, interior and exterior | 1. Coating Epoxy MIL-C-22750 Compound Bituminous<br>2. MIL-C-450 Type 2 | Same<br>Same |
| 3. Blocks | Black, TT-E-489 | Gray, TT-E-490 |
| 4. Boat falls tube | Gray, TT-E-490 | Gray, TT-E-490 |
| 5. Boat hooks | Buff, TT-E-489 | Gray, TT-E-490 |
| 6. Booby hatch exterior | Buff, TT-E-489 | Gray, TT-E-490 |
| 7. Bulwark, inboard side | Black, TT-E-489 | Gray, TT-E-490 |
| 8. Bulwark cap | Black, TT-E-489 | Gray, TT-E-490 |
| 9. Canvas items, equipment covers, etc. | Canvas preservative, TT-P-595 Haze gray | Canvas preservative, TT-P-595 Deck gray |
| 10. Capstans | Black, TT-E-489 | Gray, TT-E-490 |
| 11. Cargo battens, exterior | Gray, TT-E-490 | Gray, TT-E-490 |
| 12. Chests, deck | Gray, TT-E-490 | Gray, TT-E-490 |
| 13. Coaming, hatch | Gray, TT-E-490 | Gray, TT-E-490 |
| 14. Cockpit floor and sides | Gray, DOD-E-699 | Gray, DOD-E-699 |
| 15. Compass stand | Light gray, MIL-E-15090 | Light gray, MIL-E-15090 |
| 16. Davits | Buff, TT-E-489 | Gray, TT-E-490 |
| 17. Deck fittings, bits, cleats, chocks, etc. | Black, TT-E-489 | Gray, DOD-E-699 |
| 18. Deck machinery and controls | Black, TT-E-489 | Gray, DOD-E-699 |
| 19. Deck pads | Black, TT-E-489 | Gray, DOD-E-699 |

TABLE B-3 FINISH PAINT FOR MISCELLANEOUS EQUIPMENT (CONTINUED)

| AREA | PEACETIME | MOBILIZATION |
|---|---|---|
| 20. Doors and hatches | Same as adjacent surfaces | Same as adjacent surfaces |
| 21. Draft markings: | | |
| Light background | Black, TT-E-489 | Black, TT-E-489 |
| Dark background | White, TT-E-489 | White, TT-E-489 |
| 22. Electrical fittings and accessories | Same as adjacent surfaces | Same as adjacent surfaces |
| 23. Exhaust through transom or side | Black, DOD-P-24555 | Black, DOD-P-24555 |
| 24. Expansion trunk (tanker) | Gray, TT-E-490 | Gray, TT-E-490 |
| 25. Firefighting equipment | Red, TT-E-489 | Red, TT-E-489 |
| 26. Fittings on doors and hatches | Black, TT-E-489 | Gray, TT-E-490 |
| 27. Furniture, installed | Same as adjacent surfaces | Same as adjacent surfaces |
| 28. Galley smokepipe | | |
| Lower two-thirds | Buff, TT-E-489 | Gray, TT-E-490 |
| Upper one-third | Black, DOD-P-24555 | Black, DOD-P-24555 |
| 29. Gangways and boarding ladders | Gray, TT-E-490 | Gray, TT-E-490 |
| 30. Gratings, wood | Same as adjacent deck | Same as adjacent deck |
| 31. Guards, fenders, and chaffing strips | Same as adjacent deck | Same as adjacent deck |
| 32. Handrails, pipe, chain and stanchions | Gray, TT-E-490 | Gray, TT-E-490 |
| 33. Hawser pipes | Black, TT-E-489 | Gray, TT-E-490 |
| 34. Hawser rack | Black, TT-E-489 | Gray, DOD-P-699 |
| 35. Hose rack, fire | Red, TT-E-489 | Red, TT-E-489 |

TABLE B-3 FINISH PAINT FOR MISCELLANEOUS EQUIPMENT (CONTINUED)

| AREA | PEACETIME | MOBILIZATION |
|---|---|---|
| 36. Ladder | | |
| Non-walking surfaces | Black, TT-E-490 | Same as adjacent surfaces |
| Walking surfaces | Deck covering compound MIL-D-23003 non-skid | Same |
| 37. Lifeboats, motor launch, exterior | White, TT-E-490 | Gray, TT-E-490 |
| 38. Lifeboats interior, top of thwarts, benches | International Orange, TT-E-489 | Gray, TT-E-490 |
| 39. Life preserver boxes | | |
| Exterior | White, TT-E-490 | Gray, TT-E-490 |
| Interior | Gray, TT-E-490 | Gray, TT-E-490 |
| 40. Life preserver racks | White, TT-E-490 | Gray, TT-E-490 |
| 41. Life raft, floats, and rings | International Orange, TT-E-489 | Gray, TT-E-490 |
| 42. Life raft, supports | White, TT-E-490 | Gray, TT-E-490 |
| 43. Light screens, port | Black, TT-E-489 | Gray, TT-E-490 |
| 44. Light screens, starboard | Black, TT-E-489 | Gray, TT-E-490 |
| 45. Machinery and accessories interior of vessel | | |
| Under 300°F | Light gray, MIL-E-15090 | Light gray, MIL-E-15090 |
| Over 300°F | Gray, TT-P-28 or DOD-P-24555 | Gray, TT-P-28 or DOD-P-24555 |
| 46. Manholes and deck plates | Same as adjacent surfaces | Same as adjacent surfaces |
| 47. Mast, spars, staff and kingport | Buff, TT-E-489 | Gray, TT-E-490 |
| 48. Mast and attachments aft of stack, upper one-third | Black, DOD-P-24555 | Black, DOD-P-24555 |
| 49. Mast collars | Black, TT-E-489 | Black, TT-E-489 |
| 50. Pelorus stand | Black, TT-E-489 | Gray, TT-E-490 |

TABLE B-3 FINISH PAINT FOR MISCELLANEOUS EQUIPMENT (CONTINUED)

| AREA | PEACETIME | MOBILIZATION |
|---|---|---|
| 51. Pipe, exhaust, heating boiler, etc. | | |
| Lower two-thirds | Buff, TT-E-489<br>Gray, TT-E-490 | |
| Upper one-third | Black, DOD-P-24555 | Black, DOD-P-24555 |
| 52. Piping | Same as adjacent surfaces | Same as adjacent surfaces |
| 53. Piping interior of vessel: | | |
| Under 300°F | Same as adjacent surfaces | Same as adjacent surfaces |
| Over 300°F | Aluminum, TT-P-28 or DOD-P-24555 | Aluminum, TT-P-28 or DOD-P-24555 |
| 54. Quadrant, rudder exposed | Black, TT-E-489 | Gray, DOD-E-699 |
| 55. Rigging - running | Wire rope lubricant, MIL-L-22803 | Wire rope lubricant, MIL-L-22803 |
| 56. Rigging - standing | Wire rope lubricant, VV-L-751 Type II Grade B | Gray, DOD-E-699 |
| 57. Searchlight | Black, TT-E-489 | Gray, TT-E-490 |
| 58. Spanner wrench-stowed | Red, TT-E-489 | Red, TT-E-489 |
| 59. Stack interior | Aluminum, TT-P-28 or DOD-P-24555 | Aluminum, TT-P-28 or DOD-P-24555 |
| 60. Stair treads | Deck covering non-skid MIL-D-23003 | Same |
| 61. Switchboard, front panel | Black, TT-E-489 | Black, TT-E-489 |
| 62. Threshholds | Black, DOD-E-698 | Gray, TT-E-490 |
| 63. Vegetable lockers, on deck | Gray, TT-E-490 | Gray, TT-E-490 |
| 64. Ventilator Cowl and mushroom | Buff, TT-E-490 | Gray, TT-E-489 |
| 65. Winches | Black, TT-E-490 | Gray, TT-E-489 |
| 66. Wind and spray shields | White, TT-E-490 | Gray, TT-E-490 |

## TABLE B-4 POTABLE WATER TANK COATING SYSTEMS

**NOTE**

Painting of Potable Water Tanks shall adhere to the procedures contained in paragraph 7-6, Potable Water Tank Coating System.

| PAINT SYSTEM | COATINGS | DFT (MILS) |
|---|---|---|
| Standard Navy (MIL-P-24441) | 1 coat Formula 150 (green)<br>2 or more coats (Formula 152 (white) or 156 (red) | 1 to 4<br>1 to 4 per coat<br>Total of 8 minimum |
| Seaguard Corporation | 1 coat TANKGUARD No. 1<br>1 or more coats TANKGUARD No. 3 | 2 to 4<br>2 to 4 per coat<br>Total of 8 minimum |
| Standard Navy (MIL-P-15145) | 2 or more coats Formula 102 (zinc dust) | 1 to 2 per coat<br>Total of 4 minimum |
| International Paint Company CC25 Tank Lining System | 1 or more coats INTERGARD 4471/4473 (white)<br>1 or more coats INTERGARD 4472/4473 (blue) | 4 maximum<br>4 maximum<br>Total of 8 minimum |
| Devoe Marine Division | 1 coat DEVAR 207 (pale gray)<br>1 coat DEVAR 207 (pale yellow)<br>1 or more coats DEVRAN 207 (pale blue) | 1 to 2<br>1 to 2<br>1 to 2 per coat<br>Total of 6 minimum |

## TABLE B-5 MACHINERY AND PIPING COATINGS

### NOTES

1. To match surrounding compartment except as otherwise specified.

2. Such as boiler casings, except for those fabricated of corrosion-resistant steel.

3. Such as turbine casings, and boiler drums, pipes valves, and fittings, whether to be insulated or not.

4. Apply heat-resisting low emissivity paint (DOD-P-24555) to surfaces, where insulated or not, whose operating temperature is over 149° (300°F) and where heat radiation from those surfaces will not enter operating spaces. Also apply low-emissivity paint to surfaces, whether insulated or not, whose operating temperature exceeds 51.7°C (125°F) and where heat radiation from those surfaces will enter operating spaces. Low emissivity paint shall also be applied to normally uninsulated hot metal surfaces such as boiler drum gages and pressure gage piping. Low emissivity paint is highly flammable during application and should not be applied to surfaces whose temperature exceeds 29.4°C (85°F). Proper application is two thin coats on well-prepared dry metal surfaces. Surface preparation shall consist of removing as much rust, dirt, oil, grease, deteriorated paint and other contaminants as possible.

5. Paint galvanized and ungalvanized steel or aluminum piping below the level of floor plates with the coating system specified for the surrounding area.

6. Identify exterior valves by painting a section of the handwheel or by painting a band on the operating levers. Interior valves, except for moving parts, shall be painted. Use 2 priming and 2 finish coats on exterior surfaces when painting is specified.

7. Nonferrous and corrosion-resisting steel piping surfaces in immersion areas shall be completely coated with the same coating system for that particular tank, compartment or area.

TABLE B-5 MACHINERY AND PIPING COATINGS (CONTINUED)

| Surface | Paint System (number of coats and formula no.) | Minimum DFT (mils) | Notes |
|---|---|---|---|
| 1. Ferrous machinery surfaces (unheated, external) | 2 coats of Formula 84/47<br>1 coat of Formula 111 | 1.5<br>1.5 | |
| 2. Ferrous sheet metal surfaces (unheated, external, and internal) | 1 coat of Formula 84/47<br>2 coats of finish coat to match surrounding compartment or area | 0.5<br>3.0 | 1 |
| 3. Ferrous sheet metal surfaces (heated, external, and internal) | 2 coats of DOD-P-24555 (SH) | 3.0 | 2,4 |
| 4. Ferrous machinery surfaces (heated, external) | 2 coats of DOD-P-24555 (SH) | 3.0 | 3,4 |
| 5. Machinery gage boards (including gages and clocks) | 1 coat of Formula 84/47<br>2 coats of Formula 111 | 0.5<br>3.0 | 4 |
| 6. Thermally insulated machinery, valves, and piping | 2 coats of DOD-P-24555 (SH) under insulation<br>1 finish coat over thermal insulation | 3.0<br>1.5 | 1,4 |
| 7. Gasoline piping and valves | 2 coats of Formula 84/47<br>1 coat of TT-E-489 | 1.5<br>1.5 | 6 |
| 8. Oxygen piping and valves | 2 coats of Formula 84/47<br>1 coat of TT-E-489 | 1.5<br>1.5 | 4 |
| 9. Boilers and economizers (except parts used for heat transfer) | 2 coats of DOD-P-24555 | 3.0 | 4 |
| 10. JP-5 Piping and valves | 2 coats of Formula 84/47<br>2 coats of finish coat | 1.5<br>3.0 | 1 |
| 11. Piping, fittings and valves (galvanized and ungalvanized steel, and aluminum) | 1 coat of Formula 117<br>2 coats of finish coat | 0.5<br>3.0 | 1,4,5,<br>6 |
| 12. Nonferrous and corrosion resisting steel piping and valves, nonimmersion areas | Unpainted | | |
| 13. Nonferrous and corrosion resisting steel piping and valves, immersion areas | Paint together with surrounding immersion areas | Various | 7 |

TABLE B-6 SHIP MACHINE SHOP AND ENGINE ROOM PARTS

| COLOR | FED-STD 595 COLOR NO. | COATING | USES |
|---|---|---|---|
| Brilliant yellow | 13538 | TT-E-489 | Pulleys |
| Vivid orange | 12246 | TT-E-489 | Exposed hazards |
| Clear blue | 15177 | TT-E-489 | Switch box control panels |
| Highlight buff | 13578 | TT-E-498 | Highlight areas to concentrate attention |
| Machinery gray | To match | MIL-E-15090 or DOD-P-24555 | Body of machinery |

## TABLE B-7 SHIP TANK COATINGS

| LOCATION | PAINT SYSTEM (NUMBER OF COATS AND FORMULA NO.) | DFT (MILS) |
|---|---|---|
| 1. Chain locker | 1. 1 coat of Formula 150<br>1 coat of Formula 151<br>1 coat of Formula 153 or 152 | 2 to 4<br>2 to 4<br>2 to 4<br>(8 min. total) |
| | 2. 1 coat of TT-V-51 | 10 |
| 2. Drainage tanks, compensating fuel ballast tanks | 1. 1 coat of Formula 150<br>1 coat of Formula 151<br>1 coat of Formula 152 | 2 to 4<br>2 to 4<br>2 to 4<br>(8 min. total) |
| | 2. Class 1 or 4 of MIL-P-23236 | |
| 3. Nonfloodable voids | 1. 1 coat of Formula 150<br>1 coat of Formula 152 | 2 to 4<br>2 to 4<br>(6 min. total) |
| | 2. 2 coats of Formula 84/47<br>1 coat of Formula 23 red deck | 1.5 per coat<br>1.5 min. |
| 4. Peak tanks/ballast tank | 1 coat of Formula 150<br>2 coats of Formula 152 or 156 | 2 to 4<br>2 to 4 per coat<br>(8 min. total) |
| 5. Seawater tanks | 1. 1 coat of Formula 150<br>1 coat of Formula 151<br>1 coat of Formula 152 | 2 to 4<br>2 to 4<br>2 to 4<br>(8 min. total) |
| | 2. Class 1 or 4 of MIL-P-23236 | |
| 6. CHT tanks; sanitary tanks | 1 coat of Formula 150<br>1 coat of Formula 151<br>1 coat of Formula 151<br>1 coat of Formula 156<br>1 coat of Formula 152 | 2 to 4<br>2 to 4<br>2 to 4<br>2 to 4<br>2 to 4<br>(10 min. total) |

**NOTE**

Paint System 2 shall be utilized for touchup on areas presently coated with red lead primer Formula 116 or 116D.

## TABLE B-7 SHIP TANK COATINGS (CONTINUED)

| LOCATION | PAINT SYSTEM (NUMBER OF COATS AND FORMULA NO.) | DFT (MILS) |
|---|---|---|
| 7. Small inaccessible voids | MIL-C-16173, grade 1 | |
| 8. Lubricating oil tanks | None | |
| 9. Potable water tanks | See Table B-4 | |
| 10. Floodable but normally empty voids | 1. 1 coat of Formula 150 | 2 to 4 |
| | 1 coat of Formula 151 | 2 to 4 |
| | 1 coat of Formula 152 | 2 to 4<br>(8 min. total) |
| | 2. 2 coats of 84/47 | 1.5 per coat |
| | 1 coat of 23 red deck | 1.5 min. |

**NOTE**

Paint System 2 shall be utilized for touchup on areas presently coated with red lead primer Formula 116 or 116D.

TABLE B-8 FILM THICKNESS AND SPREADING RATE FOR UNTHINNED FORMULA PAINTS

| Formula Number | Minimum Film Thickness (mils) WFT | DFT | Theoretical Coverage (sq ft/gal/coat) | Practical Coverage (sq ft/gal/coat) |
|---|---|---|---|---|
| 5.0 | 3.1 | 1.5 | 511 | 358 |
| 20 | 3.0 | 1.5 | 541 | 379 |
| 23 | 3.1 | 1.5 | 520 | 364 |
| 24 | 3.0 | 1.5 | 535 | 375 |
| 30 | 2.9 | 1.5 | 556 | 389 |
| 34 | 8.3 | 5.0 | 193 | 135 |
| 46 | 3.1 | 1.5 | 511 | 358 |
| 84/47 | 3.2 | 1.5 | 503 | 352 |
| 102 | 4.8 | 2.0 | 333 | 233 |
| 104 | 3.6 | 1.5 | 449 | 314 |
| 109 | 3.1 | 1.5 | 512 | 358 |
| 111 | 2.9 | 1.5 | 549 | 384 |
| 117 | 5.2 | 0.5 | 308 | 216 |
| 120 | 8.8 | 1.5 | 182 | 127 |
| 121/63 | 3.3 | 2.0 | 489 | 342 |
| 122 | 5.0 | 1.5 | 321 | 225 |
| 124, 125, and 126 | 2.9 | 1.5 | 545 | 381 |
| 129/63 | 3.7 | 2.0 | 431 | 302 |
| 133 | 5.9 | 1.0 | 101 | 71 |
| 150 | 5.2 | 3.0 | 312 | 218 |
| 151 | 5.4 | 3.0 | 297 | 207 |
| 152 | 5.5 | 3.0 | 294 | 206 |
| 153 | 5.4 | 3.0 | 296 | 207 |

## TABLE B-8 FILM THICKNESS AND SPREADING RATE FOR UNTHINNED FORMULA PAINTS (CONTINUED)

| Formula Number | Minimum Film Thickness (mils) WFT | DFT | Theoretical Coverage (sq ft/gal/coat) | Practical Coverage (sq ft/gal/coat) |
|---|---|---|---|---|
| 154 | 5.4 | 3.0 | 297 | 208 |
| 155 | 5.4 | 3.0 | 300 | 210 |
| 156 | 4.9 | 3.0 | 326 | 228 |

## TABLE B-9 FILM THICKNESS AND SPREADING RATE FOR SELECTED PAINTS IN THE NATIONAL SUPPLY SYSTEM

| Coating | Minimum Film Thickness (mils) WFT | DFT | Theoretical Coverage (sq ft/gal/coat) | Practical Coverage (sq ft/gal/coat) |
|---|---|---|---|---|
| TT-P-28 | 7.0 | 1.5 | 230 | 161 |
| TT-V-119 | 3.4 | 1.5 | 470 | 329 |
| TT-E-489 | 4.4 | 1.5 | 366 | 256 |
| TT-E-490 | 3.3 | 1.5 | 492 | 344 |
| TT-P-664 | 4.2 | 1.5 | 385 | 270 |
| TT-P-666 | 3.7 | 1.5 | 428 | 300 |
| MIL-P-23377 | 3.1 | 1.0 | 526 | 368 |

## TABLE B-10 ALUMINUM BOATS SHIPBOTTOM PAINT SYSTEM

| Paint System | Coatings | Minimum DFT (mils) |
|---|---|---|
| Standard Navy | 1 coat Formula 150 (green) | 3 |
| | 1 coat Formula 151 (haze gray) | 3 |
| | 1 coat Formula 154 (dark gray) | 3 |
| | 2 coats MIL-P-15931 Formula 121/63 vinyl, antifouling red | 4 |
| | or | |
| | 3 coats Formula 150 (green) | 9 |
| | 2 coats MIL-P-15931 Formula 129/63 vinyl antifouling black | 4 |
| | or | |
| | 1 coat Formula 117 (blue) | 0.5 |
| | 4 coats Formula 120 (green) | 6 |
| | 2 coats MIL-P-15931 Formula 121/63 red/129/63 black | 4 |
| Glidden Paint Co. | 1 coat Nupon primer | 2 |
| | 1 coat VINYL-COTE AC Brown | 2 |
| | 1 coat VINYL-COTE Metallic Mastic | 4 |
| | 2 coats VINYL-COTE NO-COP (black) or (red) antifouling | 4 |
| Ameron Corp., Protective Coatings Div. | 1 coat AMERCOAT 83 Primer | 2 to 4 (Note 1) |
| | 1 coat AMERCOAT 84 Topcoat | 2 to 4 (Note 1) |
| | 2 coats AMERCOAT 235 Antifouling | 4 |

**NOTE**

The total minimum DFT for AMERCOAT 83 plus AMERCOAT 84 shall be 8 mils.

TABLE B-11 COATING SYSTEMS FOR EXTERIOR ALUMINUM SURFACES

**NOTE**

Epoxy Primer, MIL-P-23377, has a low temperature flashpoint which presents a fire and explosion hazard. Review Section 2, Safety Information.

| Optimum System | | Alternative System | | Conventional System | |
|---|---|---|---|---|---|
| Coats | Coating | Coats | Coating | Coats | Coating |
| 1 | Epoxy primer (MIL-P-23377) | 1 | Epoxy primer (Formula 150) | 1 | Pretreatment Primer (Formula) 117, if available) |
| 1 | Epoxy paint (Formula 151) | 1 | Epoxy paint (Formula 151) | 2 | Zinc Chromate (Formula 84) |
| 2 | Silicon alkyd (Haze gray TT-E-490) | 2 | Silicone alkyd (Haze gray TT-E-490) | 2 | Silicone alkyd (Haze gray TT-E-490) |

## APPENDIX C

### TABLE C-1 POWER TOOLS FOR SHIPBOARD CLEANING

| Electric (power) Tool | NSN or Commercial Source | Shipboard Use |
|---|---|---|
| ERS portable rotary scaling and chipping tool w/ cutter bundles 115 VAC or VDC | NSN 5130-00-288-6577 | Remove rust, paint, scale |
| ERS cutter bundles (replacement) | NSN 5130-00-287-5199 | |
| Tennant Model K DC deck scaling machine 220 VAC, 440 VAC, 550 VAC | NSN 4940-00-595-9735 G.H. Tennant Company, Minneapolis, MN | Scaling, wire brushing or sanding deck (large areas) |
| Tennant Model C DC deck scaling machine (portable) 230 VDC, 220 VAC, 440 VAC | NSN 4940-00-293-1460 G.H. Tennant Company, Minneapolis, MN | Scaling, wire brushing or sanding deck (large areas) |
| ES portable disk sander w/ three disks universal motor 115V | NSN 5130-00-203-4857 (7-inch)<br>NSN 5130-00-203-4856 (9 1/8-inch) | Adaptable, used w/wirecup wheel wire brush |
| EG portable aerial grinder w/abrasive wheel universal motor 115V | NSN 5130-00-224-6504 (5-inch)<br>NSN 5130-00-540-0120 (6-inch) | Adaptable, used w/cup or wheel wirebrush |
| PWG pneumatic vertical grinder w/o wheels or brushes | NSN 5130-00-184-0090 (6-inch) | Adaptable, used w/cup wheels and cup-type wire brushes |
| PG pneumatic horizontal aerial grinder w/o wheels or brushes | NSN 5130-00-242-0581 (6-inch)<br>NSN 5130-00-190-6434 (8-inch) | Adaptable, used w/radial-type or cup-type wire brushes |
| EHS portable scaling hammer w/o accessories universal motor 115V | NSN 5130-00-294-9509 | Remove rust and paint (0.495-inch shank diameter) |
| PHS portable pneumatic scaling hammer | NSN 5130-00-190-6442 | Remove rust and paint |
| PSC pneumatic hammer w/ three chisels, CECO SC-3 scaler | Open purchase from: Cleco Pneumatic, P.O. Box 40430, Houston, TX 77040 | Remove rust and paint |

TABLE C-1 POWER TOOLS FOR SHIPBOARD CLEANING (CONTINUED)

| Electric (power) Tool | NSN or Commercial Source | Shipboard Use |
|---|---|---|
| BI-BNB-pneumatic needle gun | Open purchase from: Cleco Pneumatic, P.O. Box 40430, Houston, TX 77040 | Remove paint and rust |

# APPENDIX D

## MARKINGS

## INDEX

| | Page |
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**NOTE**

Dimensions are fractional part of stack height (H).

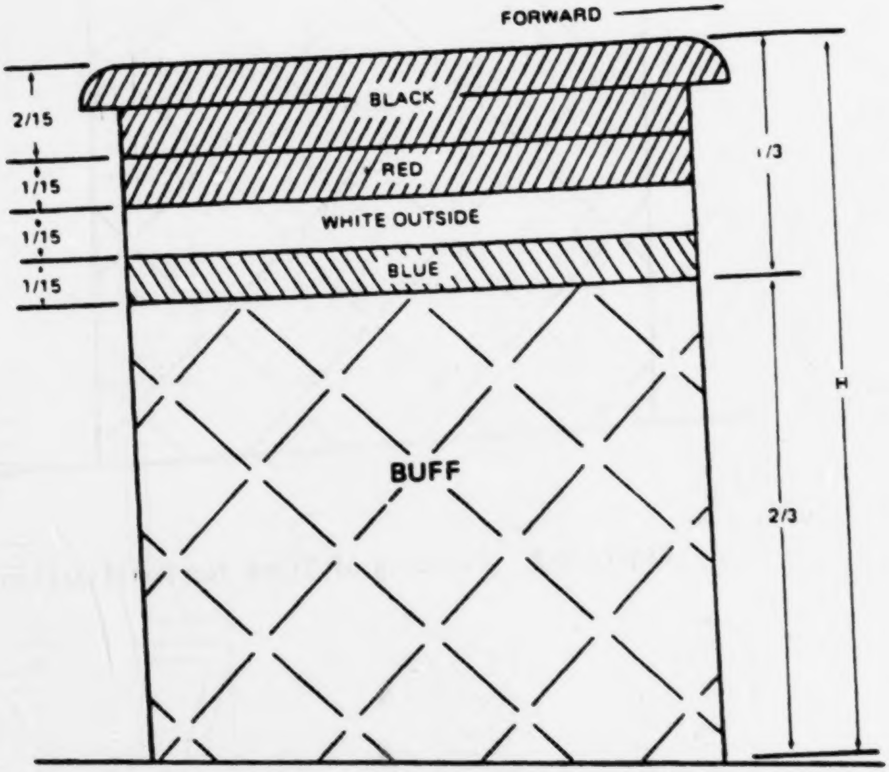

FORWARD
2/15
BLACK
1/15
RED
1/15
WHITE OUTSIDE
1/15
BLUE
1/3
H
BUFF
2/3

Figure D-1. Painting of Stack for Peacetime

**NOTE**

Dimensions are fractional part of stack height (H).

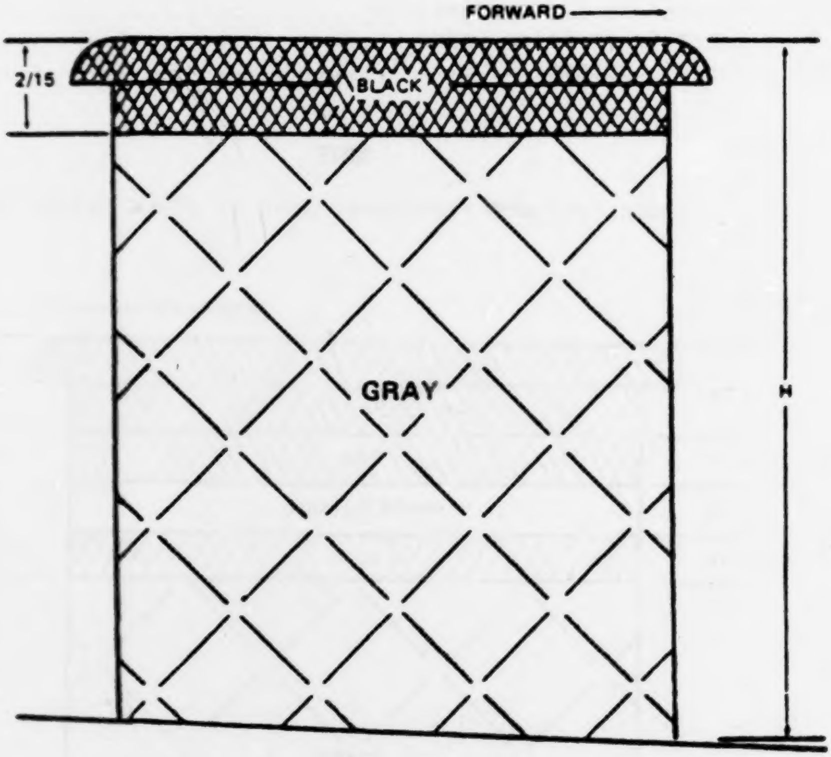

FORWARD
2/15
BLACK
GRAY
H

Figure D-2. Painting of Stack for Mobilization.

## NOTES

1. All dimensions are decimal fractions of the height "H."
2. Width of bars used for letters and numerals is 17 (1/6) of the height "H."
3. Except where otherwise shown, all outside corner bevels shall be as follows:

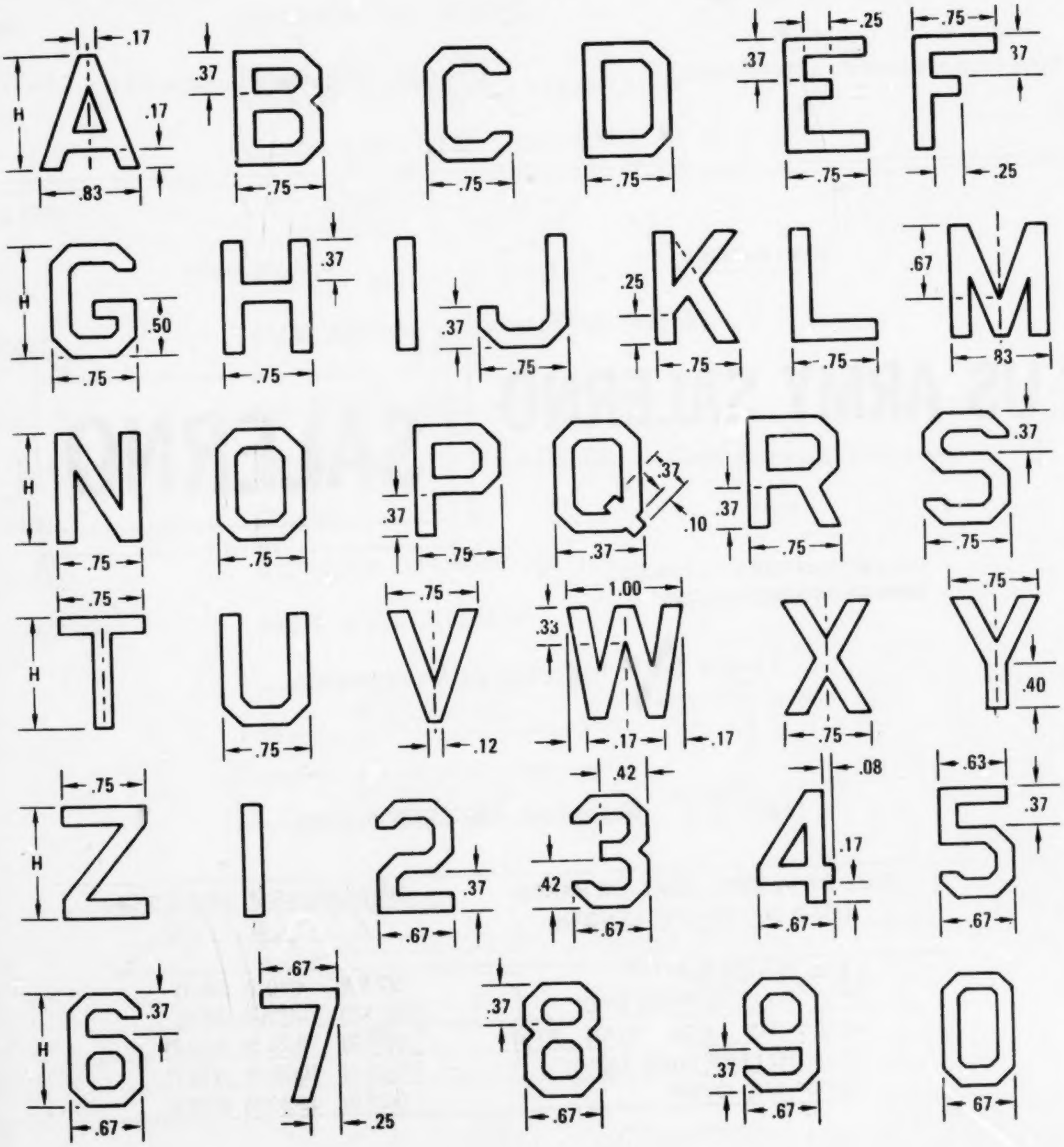
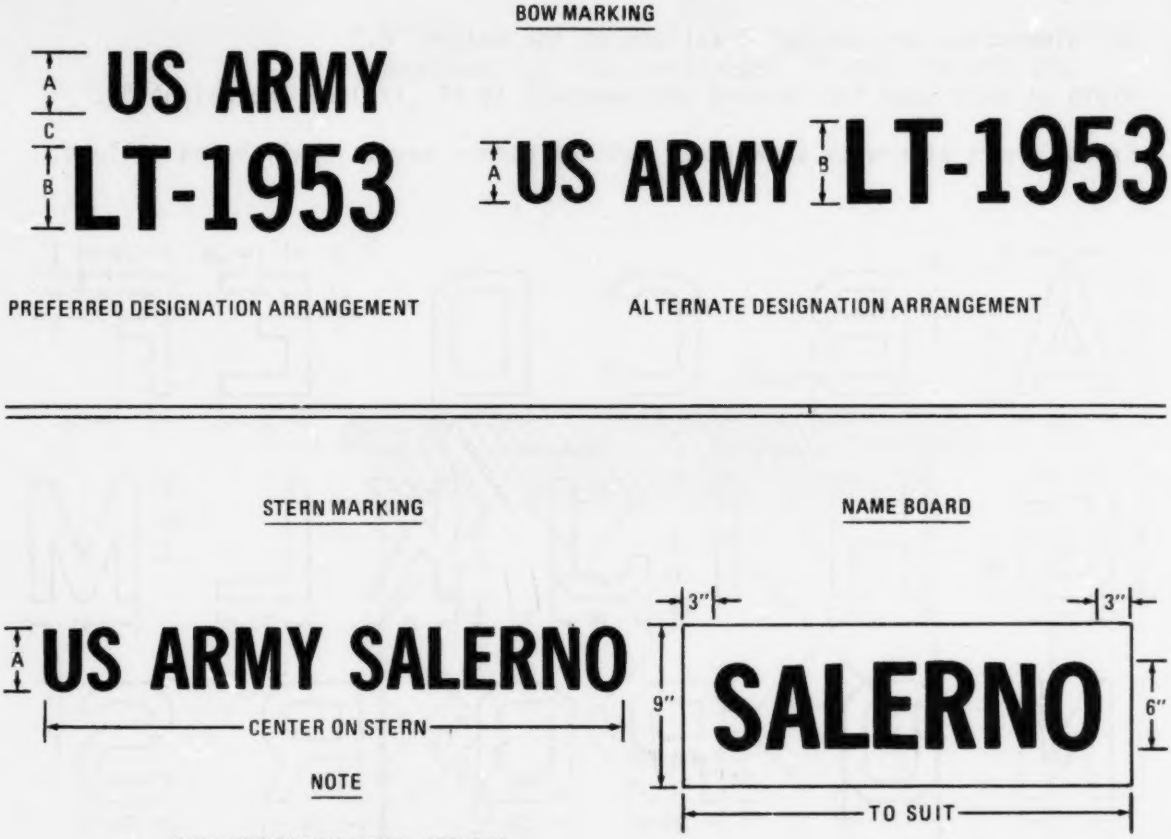

.17
H
.17
.83
.37
.75
.75
.75
.37
.25
.75
.75
37
.25
H
.50
.75
.37
.75
.37
.75
.25
.75
.75
.67
83
H
.75
.75
.37
.75
.37
.10
.37
.37
.75
.37
.75
.75
H
.75
.75
.12
1.00
.33
.17
.17
.75
.75
.40
.75
H
.37
.67
.42
.42
.67
.08
.17
.67
.63
.37
.67
H
.37
.67
.67
.25
.37
.67
.37
.67
67

Figure D-3. Block Letters and Numerals.


BOW MARKING
A
C
B
US ARMY
LT-1953
PREFERRED DESIGNATION ARRANGEMENT
A
US ARMY
B
LT-1953
ALTERNATE DESIGNATION ARRANGEMENT
STERN MARKING
A
US ARMY SALERNO
CENTER ON STERN
NAME BOARD
3"
3"
9"
SALERNO
6"
TO SUIT

NOTE

HULL DESIGNATION WILL REPLACE
NAME ON UN-NAMED VESSELS

Figure D-4. Designation Arrangements

TABLE D-1. DIMENSIONS FOR DESIGNATIONS

| SIZE OF VESSEL, BOAT, OR BARGE (LOAD WATER LINE LENGTH) | DIMENSIONS IN INCHES(CM) A | B | C |
|---|---|---|---|
| LESS THAN 20'-0" | 3(7.62) | 4(10.2) | 2(5.1) |
| 20'-0" TO LESS THAN 40'-0" | 4.5(11:4) | 6(15.2) | 3(7.6) |
| 40'-0" TO LESS THAN 70'-0" | 6(15.2) | 8(20.3) | 4(10.2) |
| 70'-0" TO LESS THAN 150'-0" | 7.5(19.1) | 10(25.4) | 5(12.7) |
| 150'-0" AND OVER | 9(22.9) | 12(30.5) | 6(15.2) |

TABLE D-2. WATER CRAFT COLOR CODES

| COLOR | APPLICATION |
|---|---|
| DARK GREEN | BILGE SYSTEM, SEA WATER SYSTEMS |
| PURPLE | REFRIGERANT SYSTEMS |
| GRAY | COMPRESSER AIR SYSTEMS |
| YELLOW | DIESEL FUEL SYSTEMS<br>GASOLINE CONTAINERS - PAINT ENTIRE |
|  | NAPHTHA CONTAINERS - CONTAINER |
| ORANGE | LUBRICATING OIL<br>HYDRAULIC OIL |
| RED | FIRE EXTINGUISHING SYSTEM |
| BLACK | STEAM AND HOT WATER HEATING SYSTEMS |
| DARK BLUE | NON-POTABLE FRESH WATER SYSTEMS |
| LIGHT BLUE | POTABLE FRESH WATER SYSTEMS |
| GOLD | SEWAGE |
| YELLOW | OIL WATER SEPARATOR SUCTION |
| LIGHT GRAY | WASTE WATER DISCHARGE |

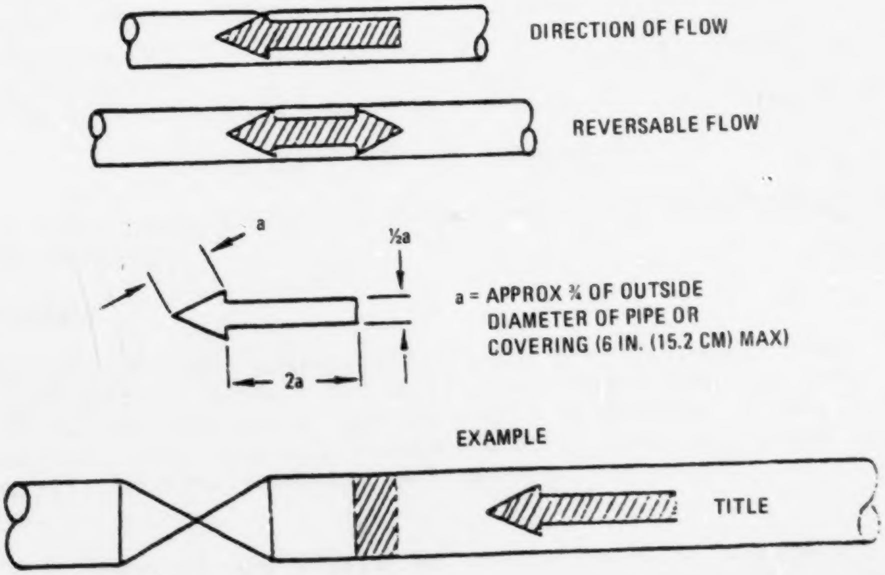

DIRECTION OF FLOW
REVERSABLE FLOW
a
½a
2a
a = APPROX ¾ OF OUTSIDE DIAMETER OF PIPE OR COVERING (6 IN. (15.2 CM) MAX)
EXAMPLE
TITLE

Figure D-5. Piping Systems.

# APPENDIX E

# DECK COVERINGS

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## SECTION I GENERAL INFORMATION

**E-1. Scope.** This appendix contains information on the installation and maintenance of deck coverings.

**E-2. Requirements.**

a. Satisfactory deck coverings for ships are lightweight, wear and skid-resistant, nonflammable, possess the ability to protect the deck from corrosion, present an attractive appearance, and are easily maintained. Simple installation and low cost are also important considerations. Since no single material is able to meet all these requirements, each material approved for use is the result of compromise.

b. Deck coverings are classified on the basis of use aboard ship. If a material is restricted to a particular class of ships, this also is indicated.

c. Spaces in which no deck covering is installed shall be painted in accordance with instructions in this TB.

**E-3. Approval.** New and experimental deck coverings shall be approved for evaluation on an individual case basis. Authorization for the installation of experimental deck coverings shall be obtained from TROSCOM. When approval is granted, full installation data and later follow up reports, shall be required.

**E-4. Installation Criteria.** In general, if the existing deck covering is functional it should not be replaced, even if it does not agree with the materials listed for the specific space. New deck coverings should be installed only where none are now present, or where existing authorized deck coverings are beyond economical repair. When repairs are required, local repairs should be made, if at all possible, rather than complete removal and reinstallation of a new deck covering. Where replacement is made the deck covering specified herein shall be installed.

**E-5. General Safety Precautions.**

a. Potential hazards are encountered in most deck covering applications. Therefore, a continuing safety program during installation is mandatory. Adherence to prescribed safety procedures will provide protection against major hazards such as fire, explosion, and toxicity.

b. Liquids, adhesives, and deck covering compounds containing volatile flammable solvents evaporate to form vapors which, if not removed or reduced in concentration by adequate ventilation, may form explosive or flammable mixtures. Every precaution shall be taken to ensure the elimination of ignition sources, such as, open flames from smoking, lighters, welding, and other operations involving sparks, that can be generated from electrical equipment. A continuous fire watch shall be maintained during application of these materials to ensure that all safety precautions are observed.

c. Vapors from some of the solvents used may have a harmful or irritating effect on the human system, particularly in confined spaces. Air respirators and eye protectors shall be worn, depending on the application. Container labels shall be read and followed for specific safety instructions concerning flammability and toxicity.

**E-6. Slip Resistant Coverings.** Since all compounds used for installation of skid-resistant deck covering contain volatile solvents which may be flammable, adequate safety measures must be taken during application.

a. Certain sensitive individuals handling the materials may develop a skin rash; therefore, gloves shall be worn. Any materials spilled on the body shall be wiped off and the skin washed with soap and water. In case of contact with the eyes, flush the eyes immediately with clear water and contact a physician. Clothing and gloves contaminated with the uncured resins shall not be worn again until they have been thoroughly cleaned. Because some formulations may use materials that fume when in contact with air, adequate exhaust ventilation is necessary in closed spaces. If the proper precautions are taken to ensure cleanliness, ventilation, and protective clothing, no difficulty should be encountered in using or handling epoxy, resins, hardeners, or solvents.

b. The following safety precautions shall be observed for interior areas where non-skid materials are rolled, trowled, or sprayed for a minimum of one hour after the non-skid has cured.

(1) Ensure absence of ignition source; all welding, smoking, hot work, open flames, energizing and de-energizing of electrical circuits in the compartment and adjacent areas shall be prohibited. Only explosion-proof lights shall be used and all portable electrical wiring shall be inspected for cracks and wear prior to use.

(2) Use exhaust ventilation, preferably air-driven, to open air to reduce the solvent vapor concentration below the lower explosive limit. Ship's exhaust ventilation in the area shall be secured and masked, supply left open. If it is necessary to use electrical motor-driven exhaust fans, only explosion-proof equipment shall be used. Ground all exhaust ventilation for electrostatic discharge, using approximately AWG20 cable with metal clips for attaching equipment to ground.

(3) Portable dry chemical fire extinguishers shall be readily available.

c. For more detailed information concerning safety of various non-skid materials in use, refer to paragraph E-18, Slip-Resistant Deck Covering, for specific safety measures that must be observed.

**E-7. Resin Seamless and Resin Terrazzo Deck Coverings.** Since many of these products/systems utilize volatile solvents that may be flammable or injurious to health, safety measures must be implemented during and after application. During the application and for a time thereafter, until the material has cured and all vapors dissipated to the exterior of the ship, follow the safety measures prescribed in paragraph E-6. Slip Resistant Coverings.

**E-8. Surface Preparation.** Before any deck covering is applied, the deck shall be cleaned free of rust, loose scale, and dirt. Grease and oil shall be removed with approved solvents and clean rags. Paint and primers well adhered to the deck may remain intact unless otherwise specified herein. All attachments to the penetrations of the structure to be covered, should be completed. When resilient deck coverings are installed, it is important that the surface to be covered be level and as smooth as possible. Unless properly faired, welds and high spots will show through resilient deck covering such as deck tiles or resilient sheet and will cause excessive wear in these areas. In such cases, if practicable, weld seams and high spots (those in excess of 1/16 inch) should be ground down to 1/16 inch and faired with underlay. Dished (concave) areas in deck plate should be filled with underlay.

**E-9. Extent of Coverage.** The deck covering should normally cover the entire deck area of the compartment, except that it should not be installed under enclosed built-in furniture nor under equipment with enclosed foundations unless otherwise specified. If desired, resilient tile may be squared off at stiffeners (except at doors), and bare steel deck sections may be painted a harmonious color.

## E-10. Deck Paint.

a. Decks should be cleaned, prepared, and primed as specified herein prior to installation of deck covering. Areas for which no deck covering is specified should be painted as required by this TB.

b. Deck paint should not be applied over deck coverings, especially slip-resistant deck coverings, except where noted herein for cosmetic purposes. Both paint and floor wax destroy the non-skid properties of slip-resistant materials. Deck paint, thinned with paint thinner to the consistency of a stain, may be used with restraint.

### TABLE E-1. APPROVED DECK COVERING MATERIALS

1. Slip-resistant deck covering materials conforming to MIL-D-24483 or other equivalent material approved herein may be used in interior spaces in lieu of treads if the safety requirements outlined in paragraph E-6 are followed. In ammunition and missile stowage spaces where forklift trucks are used (but not where hypergolic liquids are stowed) or where decks are raised by dunnage tracks in ammunition and missile stowage where forklift trucks are used, slip-resistant treads conforming to MIL-D-17951 shall be installed. Install treads approximately 3 inches apart and apply two thin coats of aluminum paint, FED SPEC TT-P-28, 1 mil dry-film thickness (minimum), between the treads to permit the dissipation of any static electricity generated by forklift trucks.

2. Magnesite and latex mastic are solid colored systems which may tend to amplify the presence of dirt and soil. If appearance is a prime concern, substitute terrazzo or other approved wet-space system.

3. If electrical equipment is installed in this space, treat as an electronic space.

4. Latex mastic may be substituted for terrazzo in shower stalls. For harmony, use a color to blend with the compartment colors.

5. Deck within the coaming around foam proportioner stations (or laundry) shall be coated with three coats of epoxy paint, MIL-P-24441. The first coat shall be Formula 150. The second coat shall be Formula 151. The third coat shall be Formula 151 or 156. Each coat shall be applied to a minimum dry-film thickness of 2 mils.

6. Slip-resistant covering to be installed in normal machinery maintenance areas to enhance safe footing.

7. Slip-resistant coverings must be applied to the top of bulwark rails and the top of bitts used for on-off access on all vessels.

| SPACE | MATERIAL |
|---|---|
| EXTERIOR (SURFACE SHIPS - STEEL) | |
| Traffic areas (1), (7) | Slip-resistant covering |
| Working areas (areas outside of direct traffic routes surrounding topside equipment such as gun circles, lookout stations, areas around deck machinery, boats, and replenishment-at-sea stations). | Slip-resistant covering |
| Hazardous areas on mainmast, yardarms, antenna platforms, and other areas considered hazardous under wet conditions. | |
| INTERIOR (SURFACE SHIPS - STEEL) | |
| Ammunition stowage, handling room, ready service room (in traffic and working areas only) | Slip-resistant covering (1) |
| Auxiliary battle dressing station | Deck tile |
| Auxiliary machinery spaces (in areas of possible lubricant or hydraulic fluid spills or leakage, except where nonslipplates or gratings are installed). | Slip-resistant covering (6) |
| Avionics shop | Deck tile and electrical grade mat (3) |
| Battle dressing station | Deck tile |
| Bread room | |
| Captain's stateroom, cabin, and sea cabin | Carpet |
| Captain's galley | Terrazzo, magnesite, mastic, or ceramic tile (2) |
| Crew galley (outside steam kettle) | Terrazzo, magnesite, or mastic (2) |
| Crew galley (within coaming under steam kettle) | CRES pan |
| Crew library | Deck tile or carpet |
| Crew or crew and troop living space | Deck tile |
| Crew messroom | Deck tile |
| Crew recreation room (not part of a living space) | Deck tile |
| Crew shelter and food service pantry | Deck tile or terrazzo |
| Crew washroom, water closet, and shower space | Terrazzo or ceramic tile |
| Fog foam injection station (within coaming) | Resin terrazzo or epoxy paint (5) |
| Electronic spaces (manned) including, but not limited to, main comm., and CIC | Electrical grade sheet or deck tile with electrical grade mat |

## INTERIOR (SURFACE SHIPS - STEEL) (Continued)

| | |
|---|---|
| Ladies room | Deck tile |
| Laundry (within coaming) | Mastic or epoxy paint (5) |
| Laundry | Deck tile |
| Laundry issuing and receiving room | |
| Motion picture projector room | Deck tile |
| Navigator sea cabin | Deck tile |
| Navigator stateroom | Deck tile |
| Offices | Deck tile |
| Officer washroom, water closet, and shower space (5) | Terrazzo or ceramic tile |
| Passages (serving, living, messing, medical, dental, and office spaces) | Deck tile |
| Post Office | Deck tile |
| Radio center/room | Electrical grade sheet or deck tile with electrical grade mat |
| Scullery | Mastic, terrazzo, magnesite, or ceramic tile |
| Scullery passage | Deck tile |
| Ship control spaces (pilothouse, chartroom communication spaces, and conning towers) | Deck tile and fiber mat at weather door |
| Ship store | Deck tile |
| Shops (walking areas around power tools) | Slip-resistant treads |
| Stateroom | Deck Tile |
| Steering stations | Watch station mat |
| Switchboards, electrical | Electrical grade mat or sheet |
| Troop living space | Deck tile |
| Vegetable preparation room | Terrazzo, magnesite, or mastic (2) |
| Wardroom bunkroom | Deck tile |
| Wardroom galley (outside steam kettles | Terrazzo, magnesite, or mastic |
| Wardroom galley (within coaming under steam kettles) | CRES pan |
| Wardroom lounge | Carpet or deck tile |
| Wardroom messroom | Deck tile or vinyl sheet |
| Wardroom pantry | Terrazzo, magnesite, mastic, or ceramic tile |
| Washroom and water closet and shower space (5) | Terrazzo |
| Watch stations | Watch station mat |

## MISCELLANEOUS

| | |
|---|---|
| Dry side of doors to weather decks | Door mat, portable |
| Operating and servicing areas in way of electric and electronic equipment (for prevention of electric shock) | Electrical grade mat or sheet |
| At each side of door with high coaming normally used for continuous traffic, and at the head and foot of ladders at each side of door in crew messroom | Slip-resistant treads (3-treads) |

## SECTION II MATERIALS AND APPLICATION

### E-11. Resilient Roll or Sheet and Fire-Retardant Deck Tile.

a. General.

(1) Tile, roll, or sheet deck materials shall be installed over wood or plastic decks, or over metal decks that have been prime-coated with epoxy formula 150 of MIL-P-24441 or other approved primer. Where necessary to level or slope the deck, to level fair welded seams, or to fill in depressions, underlay conforming to MIL-D-3135 shall be applied over the primed deck. Deck tiles and sheet material shall be cemented to the metal deck, over the primer or underlay, with latex adhesive, MIL-A-21016. However, in damp or wet areas an epoxy type adhesive, MIL-A-24456 or equivalent, should be used. When an entire space is to be retiled, an asbestos-free material shall be used.

(2) If fewer than 25 percent of vinyl asbestos deck tiles in any one area require repair or replacement, tiles of the original color and pattern should be used. Tiles or sheet shall not be installed more than two layers thick because of the increased fire hazard. They may be installed over one existing layer provided that the existing material is well adhered to the deck and that gouges and worn areas are first repaired. Immediately after tile or sheet is installed, the deck should be rolled thoroughly in both directions with a 150-pound sectional roller to ensure adhesion follow safety precautions in ripping out and handling vinyl-asbestos tile.

b. Materials. The following fire-retardant deck covers are approved for use as indicated.

(1) Asbestos-Free Deck Systems. Materials approved as asbestos-free alternatives to vinyl-asbestos deck tile include:

(a) Plastic deck tiles conforming to MIL-T-18830, such as Armstrong World Industries Inc., Excelon Supreme Vinyl Corlon or GAF Corporation Gafstar Regency Vinyl Composition Floor Tile. The following tiles are available in 12-inch squares:

| NSN | Color |
|---|---|
| 7220-01-102-5989 | Warm White |
| 7220-01-101-1222 | Cool White |
| 7220-01-101-1223 | Cream |
| 7220-01-101-1224 | Beige |

(b) Vinyl or rubber floor coverings, conforming to FED SPECS SS-T-312, L-F-475, L-F-450 and to the fire requirements of MIL-STD-1623. For additional information, see paragraphs (2) and (5) below.

(c) MIL-M-15562, Type I.

(2) Rubber Deck Tile and Rubber Sheet Materials. Rubber tile and sheet materials shall conform to FED SPEC SS-T-312, type II, with one exception; sheet material is exempt from dimensional requirements, because it is available

in widths of 36 inches. minimum. Both rubber tile and rubber sheets are required to meet the fire standards of MIL-STD-1623 and both are required to be 1/8-inch thick for maximum durability.

(3) Homogeneous Vinyl Tile and Sheet. Vinyl deck tiles shall conform to FED SPEC SS-T-312, type III, and shall be 1/8-inch thick for maximum durability. Vinyl sheet shall conform to FED SPEC L-F-450. Both tile and sheet must conform to MIL-STD-1623.

(4) Vinyl Floor Covering with Backing. Vinyl deck covering with a backing, FED SPEC L-F-475, grade A, may be used if the material conforms to the fire test requirements specified in MIL-STD-1623.

(5) Fire Retardant Plastic Deck Tile. A list of fire retardant vinyl-asbestos plastic deck tile materials for repair purposes is provided in table E-2.

TABLE E-2. VINYL-ASBESTOS FIRE-RETARDANT DECK TILE

| Color | Pattern No. | National Stock No. | |
|---|---|---|---|
| | | 12-Inch Squares | 9-Inch Squares |
| Black with white texture | 101 | 7220-00-144-5032 | 7220-00-634-5320 |
| Red with white texture | 106 | 7220-00-144-5033 | 7220-00-634-5322 |
| Green with white texture | 108 | 7220-00-144-5034 | 7220-00-634-5321 |
| Gray with black and white texture | 111 | 7220-00-144-5035 | 7220-00-543-7156 |
| Brown with white and terra cotta texture | 112 | 7220-00-144-5036 | 7220-00-543-7157 |
| Charcoal with red and white texture | 113 | 7220-00-144-5053 | 7220-00-543-7158 |
| Tan with white, coral, and brown texture | 114 | 7220-00-144-5056 | ---------------- |
| Light blue with white, tan, grey, and brown texture | 115 | 7220-00-144-5057 | ---------------- |

c. Installation. Immediately prior to installation, all deck covering and adhesives shall be stored for at least 24 hours at a temperature of 21°C (70°F) or higher. Spaces shall be maintained at a temperature of at least 21°C (70°F) prior to, during, and 24 hours after installation is completed. A beading sealer (NSN 9Q 8030-00-264-3886) shall be used to waterproof all seams against bulkheads, stationary furniture, pipes, and other deck fittings. Where weld lines (beads) prevent deck covering from butting tightly against structure, calking compound, MIL-C-18255, shall be used in lieu of tile adhesive and should be painted to blend with the deck tile or bulkhead (after the calking compound skins over); alternatively, the weld line against bulkhead may be faired with the underlay and the tile butted against the bulkhead. The latter method presents a better appearance. If desired, the tile may be squared off adjacent to vertical stiffeners and stanchions.

d. Preparation of Steel Decks. Steel decks shall be clean, free from oil, grease, rust, and loose scale. It is not necessary to remove red lead or zinc-chromate priming paint, or deck paint if well bonded to deck; otherwise, loose paint, rust, and scale should be removed by blasting, wire brushing, or other effective method. The deck shall then be washed with paint thinner to remove grease and contaminants and steel primed with formula 150, MIL-P-24441, 2- to 4-mils dry-film thickness. If possible, weld seams should be ground flush with the deck, and all low spots should be filled with underlay, MIL-D-3135, type II. All high spots should be ground down, if possible, or faired with underlay before applying the primer. The deck must be dry at the time the deck covering is installed.

e. Application of Deck Tile. Pointers for laying vinyl asbestos, rubber, and vinyl tile are as follows:

(1) Prior to installation, tiles should be stored for 24 hours at a minimum temperature of 21°C (70°F) (at temperatures below 21°C (70°F) the material is not sufficiently flexible for satisfactory installation). To ensure straight seams, areas to be covered should be squared off and, if practicable, the installation of tile should be started at the center of the space and worked to the edges, to achieve an even balance of tile around edges of the space.

(2) If a pattern of two or more colors is desired, plan this on graph paper in advance (each square of the paper can be considered one tile). For spaces with non-parallel opposite bulkheads, use a large square and chalk line at corners to square off the compartment into a rectangular or square layout. To locate the center of the space, strike a chalk line from midpoints of opposite bulkheads after squaring off.

(3) It is important that installation start at sections of the space where work can proceed to completion without kneeling on freshly laid tile. Cement conforming to MIL-A-21016, or as otherwise specified, should be spread with a fine-toothed trowel (approximately 1 square yard at a time) at a coverage rate of 100 square feet per gallon (excess cement will reduce adhesion). While the cement is tacky, the tiles should be forced into tight contact with each other. Each tile should be flexed downward slightly saucerwise so that the four corners hit the deck first. (The roller takes care of bringing the center into the cement.) Half tiles can be cut by scoring and cutting through with a sharp knife. A dull or unpointed linoleum knife should not be used for tile cutting because the cut edges will be uneven. Care should also be taken that the cement does not get on tile surfaces; excess wet cement may be cleaned off with a damp rag; excess dry cement with a rag wet with paint thinner. Pressure should be applied to ensure complete contact of each tile with the deck. Any high joints remaining after this operation should be rubbed even and smooth with the head of a hammer or a hand roller.

(4) Installations should be made bulkhead to bulkhead, or squared off adjacent to stiffeners and stanchions. Where an exposed edge fails to butt up against a fitting or bulkhead, a stainless steel or brass strip (1 inch by .08 inch) should be screwed, cemented (with epoxy or polysulfide adhesive), or welded to the deck to protect the edge. A vinyl-asbestos, beveled-edging strip (cemented to the deck with rubber latex cement) may also be used.

(5) Travel over the newly cemented areas should be restricted until the installation is completed; thereafter the deck can be opened to foot traffic immediately, since no indentations will result from this type of traffic. However, it is recommended that heavy concentrated loads, such as legs of heavy furniture, be kept off the deck until the cement has set (approximately 18 hours). Water can affect adhesive and loosen tiles; therefore, the deck should not be swabbed for 1 week after installation. Thereafter, for general cleaning, water should be used sparingly to prevent corrosion under tiles.

f. Installation of Rubber Roll, Vinyl Sheet, or Mat.

(1) When installing these materials in front of equipment only, cut the sheet to the desired length, and with a straight edge, cut off the selvage (if applicable) before cementing the sheet. When installing sheeting material over an entire deck area, lay out the material, cutting all sheets to the desired length; then overlap sheet edges so that all seams can be double cut, using a straight edge, to assure tight fit. After the material has been cut and fitted, roll sheets back and cement half the area; then repeat the process for the other half.

(2) When cementing, use a latex-type adhesive conforming to MIL-A-21016. If the sheet has a tendency to bubble or lift after installation, a stronger adhesive should be used for subsequent installations. Use an epoxy adhesive such as AMTICO NO. 529 (American Biltrite Company), MILLMARK No. 7 (Mastic Tile Rubberoid Corporation).

(3) Spread the adhesive with a notched trowel, making certain that the entire surface is covered. When the adhesive is tacky, install the sheet. Immediately after installation thoroughly roll the deck in both directions with a 150-pound sectional roller.

(4) For additional information concerning materials used to prevent electric shock, refer to paragraph E-15, Electric Shock Prevention.

g. Repair or Replacement of Deck Tiles. If a tile requires replacement, remove by forcing a wide-blade paint scraper under it. Inspect for corrosion. Chip out the dried cement and corrosion products to bare steel, clean the spot with paint thinner, coat with primer, and install tile as previously described.

## E-12. Latex Underlay.

a. General. Latex underlay should conform to MIL-D-3135, Type I (NSN 5610-00-141-7958 and 5610-00-141-7959), for use under latex terrazzo, latex mastic; and ceramic tile.

b. Surface Preparation. Remove rust and paint. Clean deck free of oil, grease, and dirt with an approved degreasing solvent, such as type II of FED SPEC P-D-280 (NSN 6850-00-274-5421, 5 gallons or 6850-00-110-4498, 1 pint). Apply one coat of epoxy primer, formula 150, MIL-P-24441, 2-to 4-mils dry film thickness, in accordance with Section 6.

c. Surface Wetting Coat. One part rubber latex mixed thoroughly with 2 parts underlay powder (both by weight) should be brushed on in a thin coat, assuring that the entire deck is thoroughly wet. The purpose of the wetting coat is to assure that the underlay bonds securely to the surface.

d. Underlay Body Coat. Mix thoroughly (by weight) 1 part rubber latex, 1-½ parts of underlay powder, and 1-½ parts underlay aggregate. Mix only in such quantity that the material will not set up before application. Make certain there are no dry particles left. The following approximate quantities of materials are required to cover 100 square feet (¼-inch thick):

49 pounds rubber latex
73 pounds underlay powder
73 pounds underlay aggregate

While the surface wetting coat is still wet, trowel on the underlay body coat and level off with battens. After leveling off, go over the surface with steel trowels, working down hard, to flow the mix together, and to blend it with the surface wetting coat. Allow to dry hard (at least 2 days) before application of deck covering. If the underlay is used in excess of ½-inch thick in one layer, it wil tend to develop hairline cracks. Latex underlayment for use under deck tile and resilient sheeting should conform to MIL-D-3135, type II, and should be installed in accordance with the manufacturer's directions. Type II can be feather-edged and trowelled to a smooth finish without sanding.

e. Insulation Type Underlay. Insulation underlayment may be used to prevent condensation in certain areas, e.g., above ballast tanks and hot machinery spaces, especially where these decks form the deck tops of living spaces. Magnesia insulation shall conform to MIL-D-23134.

f. Surface Preparation. Remove rust, dirt, old paint, oil, and grease from the deck. Clean up all traces. Apply one coat of epoxy primer, formula 150, MIL-P-24441, 2- to 4-mils dry-film thickness.

g. Installation. The on-deck magnesia insulation shall be trowelled smooth, a minimum of 1-inch thick over rough finish latex underlay (MIL-D-3135, type I), installed at least 1/8-inch thick. Exposed aluminum fittings shall be protected from corrosion by the magnesia by either a coating satisfactory for aluminum or a suitable covering such as wrapping with a vinyl tape.

### E-13. Terrazzo.

a. General. Terrazzo is defined as a composition material, poured in place or precast, and used as a deck covering. It consists of marble chips, seeded or unseeded, with a binder or matrix that is cementitious, noncementitious, or a combination. The terrazzo is poured, cured, and then ground and polished to expose the marble chips at the surface.

b. Latex-Type Terrazzo. Latex-type terrazzo, MIL-D-3134, type I, class I, is a trowel-applied material containing white or colored marble chips. It is packaged in the form of liquid latex (in cans) and aggregate and powder (in bags). Components are mixed at time of application resulting in a mastic consistency suitable for application with a steel trowel. The specified thickness for application is ¼ inch, which weighs approximately 3 lbs per square foot. This decking may be applied to a maximum thickness of ½ inch without sagging of the wet mix. For greater thickness, apply latex underlay first. A 2- to 4-inch high cove of terrazzo, type I, should be installed. After application, latex-type terrazzo requires machine-grinding to provide a smooth surface.

(1) Material. Required materials (by National Stock Number) include:

| | |
|---|---|
| Latex Emulsion | (NSN 5610-00-285-1458) |
| Terrazzo Mix | (NSN 5610-00-285-1455) |
| Grout | (NSN 5610-00-285-1457) |

(2) Surface Preparation. The deck, including the vertical bounding surface against which the covering will abut, is cleaned to bright steel by blasting, wire brushing, or similar method and given a solvent wash with an approved solvent such as 1.1.1 trichoroethane. The steel is then primed with epoxy primer, formula 150, MIL-P-24441, 2- to 4-mils dry-film thickness.

(3) Application. Mix, apply, grind, and seal in accordance with manufacturer's specific instructions. The final product should be nonporous, smooth, and free of pits, spalls, and crevices. The marble chips should be uniformly distributed, firmly embedded, and exposed at the surface. Divider strips, if installed, shall be set in accordance with the selected layout while the underbed is still plastic. Set strips straight to lines and at the proper level to ensure that the tops of strips will show uniformly after grinding and finishing operations. Fit end joints and intersections tightly. Where divisions in field work are not shown, divide field work into uniformly-sized squares or rectangles no more than 6 feet on a side. Place edging strips where terrazzo abuts other types of deck covering at doorways. Install expansion strips at control joints, construction joints, and expansion joints.

(4) Maintenance. Cleaning maintenance shall consist of washing with hot water and detergent.

(5) Restoration of Color. To restore the deck covering color, lightly sand with No. 0 steel wool or No. 60 sandpaper. In some cases, a light mechanical sanding may be necessary to bring out the original color. Vacuum thoroughly to remove dust. Brush on two or more thin coats of sealer to preserve (allowing a minimum of 2 hours drying between coats). Keep traffic off the deck until thoroughly dry.

(6) Sealing. Sealing consists of applying a thin, clear sealing liquid conforming to MIL-S-24522 or equivalent over the entire terrazzo surface, usually in several coats, to provide a nonporous film which acts as a barrier against the buildup of moisture, dirt, and grime. If the surface is maintained by periodic resealing, colors remain bright and attractive indefinitely, and the deck is protected against excessive wear and deterioration. Deterioration can result when water and moisture are permitted to penetrate the terrazzo surface and rust the steel substrate, undermining the entire deck structure.

(a) For new installations, at least two coats of sealer are required as a final surface; in some cases three or more coats may be required. These should be applied by the installing activity. The sealing process is complete when the deck has a uniform appearance, i.e., when the surface film is continuous and free of blotchy areas.

(b) Existing terrazzo decks are usually resealed with one application after the deck has been cleaned with a free-rinsing detergent (NSN 7930-00-249-8036), rinsed, and dried. If the deck color has become dull and grimy, it can usually be restored by sanding with No. 0 steel wool or No. 60 sandpaper. The deck must then be vacuumed, detergent-cleaned, rinsed, and dried before applying two or more thin coats of the clear sealer. Allow approximately 2 hours between coats.

(c) The need for resealing will vary directly with the amount of traffic and environmental conditions to which a deck is exposed. It is recommended that the deck be resealed at least once every 6 months. High traffic areas may require more frequent resealing; for example, the galley and head are areas subject to greater abuse from high traffic and continuous wetting and cleaning. Therefore, galleys and heads would normally be resealed every 2 to 4 months. The effect of having too little sealer on the deck may be observed as a darkening or dulling of the color because of embedded dirt and grime. If this is the case, light mechanical abrasion with sandpaper or steel wool will be required to rejuvenate the surface.

(d) Available water-based terrazzo sealers conforming to MIL-S-24522 (by National Stock Number) include:

| NSN | Gallon |
|---|---|
| 8030-00-007-8333 | 1 |
| 8030-00-007-8334 | 5 |

(e) Terrazzo sealer spreading rate is about 800 to 1000 square feet per gallon. It may be applied by brush, mop, or as recommended by the manufacturer.

(f) Proper attention to periodic resealing will preserve the desirable qualities of the terrazzo deck, facilitate cleaning, and reduce the need for extensive repairs.

(g) Failure to seal the terrazzo properly will reduce the effective service life of the material, because water will eventually penetrate the terrazzo, resulting in loss of adhesion, blistering and cracking, and, eventually, corrosion of the steel substrate.

(7) Repairs. Even small cracks in the terrazzo should be repaired to prevent water penetration and corrosion of the steel substrate.

(a) In those areas where a crack penetrates to the steel deck, the crack may have widened so that the steel can be cleaned and roughened by mechanical means (such as wire brushing). The crack can then be patched with grouting or other nonshrinking material and the surface ground smooth and resealed.

(b) In those areas where cracking is superficial or slight, the terrazzo may be sanded or reground and resealed.

c. Resin-Type Terrazzo. Resin-type terrazzo systems are composed of a thermosetting resin (an epoxy, polyurethane, or polyester), a hardener, and marble aggregate. The marble aggregate may be incorporated in the resin or furnished separately. When mixed and applied in accordance with manufacturer's instructions, the end product is a tough, decorative, durable, impermeable, and chemical-resistant deck covering.

(1) Application. Clean, solvent wash, and prime the metal surface in accordance with paragraph E-12.b. If necessary to slope the deck toward drains or to correct deck plate irregularities, apply underlay MIL-D-3135 in accordance with paragraph E-12., Latex Underlay. Apply resin terrazzo over the primed metal or over underlay that has been allowed to dry thoroughly.

Resin-type terrazzo also requires grinding and sanding or polishing to expose the marble aggregate and to produce a surface which is smooth and aesthetic. No standards have been developed to quantitatively describe the surface finish.

(2) Maintenance. Cleaning shall consist of washing with hot water and detergent. The surface should be resealed when it begins to show signs of wear or begins to dull or lose its uniform appearance. Resealing or refinishing shall be done in accordance with paragraph E-13.b.(6) and the manufacturer's instructions.

**E-14. Rubber Standing Mat.** Rubber standing mats should conform to following specifications:

a. Barber and Dental Chair. FED SPEC ZZ-M-42, black with green and white texture, 18 pounds.

b. Showers. MIL-M-19018 (SHIPS), gray, 20 inches by 20 inches (NSN 7220-00-634-1601).

c. Watch Stations. MIL-M-910 (SHIPS), black, 30 inches by 36 inches (NSN 7220-00-292-2096).

## E-15. Electric Shock Prevention.

a. General. An insulating deck covering is necessary to prevent electric shock to persons who may touch bare, energized, ungrounded circuits while standing on bare decks. Although dry wood decks are not conductive, they constitute an electrical hazard when wet. Both metal (steel and aluminum) and wood decks require an insulating deck covering. After installation, the decking should be checked at least once annually to ensure that the surface is not cracked, punctured, or perforated and that no metal or conductive particles have become imbedded. If the decking is not cemented, check several areas with calipers. Discard and replace if any thickness is less than 1/32 inch (.03 inch). However, if the decking is cemented, the thickness should be determined at least annually using a suitable thickness gauge. A pin or needle may be inserted at a seam location (where two widths abut) and the depth measured. After test, fill the seam with a rubber adhesive to ensure integrity of the protective insulation, if required.

b. Materials. There are two types of deck covering for preventing hazardous electrical shock by insulating personnel from direct ground through the metal deck. The deck may be covered with an approved deck material specified for the space such as deck tile and an electrical insulating portable or runner-type deck matting in way of the electrical hazard areas; or an electrical grade sheet may be installed by cementing the sheet over the entire deck. Principal differences are that the sheet material is generally more attractive and is easier to maintain. If the compartment is not a designated electrical space (see table E-1) but, contains electrical equipment such as switchboards, panels or electrical insulated work benches, and is not protected with an approved electrical sheet deck covering, type I, install an appropriate length of mat, type II or III, on the deck adjacent to the electrical equipment, insulated work benches, and operating and servicing areas of electrical panels, and switchboards. The mat should be installed over the minimum area necessary to prevent electrical shock hazards, but not less than 3-feet wide. **EXPOSED** corners shall be rounded off. Cementing the mat to the deck is optional, except that the material shall be installed without cement in the vicinity of removable deck plates. (Cementing procedures herein shall be followed.) If, on the other hand, a compartment is basically electrical, install electrical grade sheet, MIL-D-15562, type I, in the entire space.

c. Electrical Grade (Dielectric) Sheet, MIL-M-15562, Type I. Approved marbleized patterns of electric grade sheet are as follows:

NSN - 7220-01-025-1695, floor covering, marbleized, color - green, synthetic rubber. (.125" x 36" x 25 yds)

NSN - 7220-01-024-9039, floor covering, marbleized, color - beige, polyvinyl chloride. (.125" x 36" x 25 yds)

NSN - 7220-01-024-9040, floor covering, marbleized, color - blue, polyvinyl chloride. (.125" x 36" x 25 yds)

NSN - 7220-01-024-9041, floor covering, marbleized, color - terra cotta, synthetic rubber. (.125" x 36" x 25 yds)

NSN - 7220-01-106-0450, floor covering, marbleized, color - blue, synthetic rubber. (.125" x 36" x 25 yds)

NSN - 7220-01-106-0451, floor covering, marbleized, color - beige, synthetic rubber. (.125" x 36" x 25 yds)

The sheet may be installed over one layer of a resilent-type deck system (vinyl, vinyl asbestos, rubber tiles, or sheet), provided that the existing covering adheres tightly to the deck and that required deck repairs have been made. The deck surface must first be cleaned with a floor stripper and detergents to remove all traces of oil, grease, soil, and old floor finishes. Prior to installing the deck covering over bare metal, prime the deck with 2- to 4-mils dry film thickness of formula 150, MIL-P-24441 or other approved equivalent. Allow the primer to dry and cure a minimum of 16 hours; then cement the electrical sheet to the deck using an approved adhesive only.

d. Portable Mat, MIL-M-15562, Type II, Smooth Surface. Stock materials which may be used as electrical insulating deck matting on surface ships are:

NSN - 7220-00-267-4630, solid blue or marbleized blue. (.188" x 36" x 25 yds)

NSN - 7220-00-913-8751, solid green or marbleized green. (.188" x 36" x 25 yds)

NSN - 7220-00-255-0765, black. (.125" x 24" x 25 yds)

Type III, Diamond Tread Pattern. Diamond tread is available in green or gray as follows:

NSN 7220-01-056-1944, green. (.188" x 36" x 25 yds)

NSN 7220-01-057-1897, gray. (.188" x 36" x 25 yds)

Deck matting is designed for interior use and is to be installed over existing deck covering or over a metal deck previously coated with 2 to 4 mils of a primer such as formula 150, MIL-P-24441, or other approved equivalent. Cementing the mat to the deck is not required for personnel safety, but if the mat is not cemented, stencil an outline of the mat on the deck. Inside the outline, stencil, **"ELECTRIC GRADE MAT REQUIRED WITHIN MARKED LINES,"** using 3/4 inch or larger letters. All existing installations of previously electrical grade matting material should be retained. Seams within 3 feet of an electrical hazard should be treated as described in paragraph e. below. Other seams may be treated in the same manner to reduce maintenance and enhance appearance.

e. Seams. Electrical insulating deck covering should be installed so that there are no seams within 3 feet of an electrical hazard. Where this is not possible, thermoplastic deck coverings, such as vinyl sheets, should be fused chemically or else heat welded or heat fused with a special hot air gun. Refer to manufacturer's installation and specification manual. With rubber deck coverings fusing with heat is not possible. With these deck covering materials, a 3- or 4-inch wide strip of #51 Scotchrap 20-mil thick Polyvinyl Chloride (PVC) tape (manufactured by Minnesota Mining and Manufacturing Company) should be installed beneath the seam to prevent a direct path to ground via the seam.

f. Cleaning and Maintenance. It is recommended that a floor finish be applied immediately after type I sheet has been installed, and that it be renewed as required in order to reduce soiling and improve appearance.

g. Required Locations. Typical areas for the application of electrical insulating deck coverings are:

(1) Operating areas in the front and rear of propulsion-control cubicles, power and lighting switchboards, interior-communication switchboards, test switchboards, fire-control switchboards, and shipboard announcing system amplifiers and control panels.

(2) The area around electronic equipment with which personnel who are servicing or tuning energized equipment may come in contact.

(3) The area around workbenches in electrical and electronic 'shops where electrical or electronic equipments are tested or repaired.

h. Deck Preparation. Prior to installation of electrical grade matting, the deck surface must be properly prepared.

(1) Over metal (steel or aluminum). Remove old paint, rust, grease, and other contaminants from the deck. Coat the deck with 2- to 4-mils dry-film thickness of epoxy primer 150, MIL-P-24441. If the deck can not be coated soon after it is prepared, it must be wiped down with a degreasing type solvent such as NSN 6850-00-274-5421 (5 gallon) or 6850-00-110-4498 (1 pint), before primer application. The matting should be placed or cemented over the primed deck.

(2) Over deck tile. If the matting is to be cemented, remove all traces of wax and dirt from the deck tiles where the matting is to be located. If a water-base or latex-type adhesive such as MIL-A-21016 is used, it is recommended that the top surface of deck tiles be lightly abraded with coarse steel wool or fine sandpaper to improve adhesion.

i. Installation. Install electrical grade matting with a cement conforming to FED SPEC MMM-A-121. National Stock numbers are:

| | | |
|---|---|---|
| NSN | 8040-00-273-8717 | (pint) |
| NSN | 8040-00-165-8614 | (quart) |
| NSN | 8040-00-843-3461 | (gallon) |

MMM-A-121 is a solvent-type adhesive and may contain flammable and toxic-type solvents. It must be used with adequate ventilation and fire safety precautions. Where adequate safety precautions cannot be ensured, use a water-base or latex-type adhesive such as MIL-A-21016. The advantage of a solvent-type cement is that it normally forms a faster, stronger bond than most water-based adhesives. Apply the adhesive (water-based or solvent-type) to both the mat and the deck. Clean the grease and mold release agents from the back side of the matting by buffing with sandpaper. If buffing is impractical, clean with a free-rinsing type synthetic detergent, NSN 7930-00-249-8036 (1 gallon), NSN 7930-00-527-1237 (5 gallon), rinse with fresh water, and allow to dry. Precoat the cleaned surface with the adhesive and allow to dry tack free (about 1 hour). The adhesive should then be applied to the prepared deck. The adhesive can be applied with a brush, roller, or trowel. Allow the adhesive to become tacky to the touch before laying the mat. After the mat has been laid on the deck, it is desirable to apply pressure with a heavy roller to ensure good contact of the mat with the deck. Matting installed over gratings or on removable deck plates or covers should not be cemented.

## E-16. Carpet.

a. General. Unless otherwise specified, shipboard carpet shall be wool, velvet, woven through the back, conforming to FED SPEC DDD-C-95, type II, class 1, 2, or 4.

b. Installation. Install the carpet directly over the metal deck as follows (note that carpet pads are not authorized):

(1) Grind down any weld seams which protrude more than 1/16 inch so that seams are no higher than 1/16 inch.

(2) Prepare deck surfaces and prime with an anti-corrosive primer, formula 150.

(3) Fair the deck with underlay, MIL-D-3135, type II on and around rivet heads, plating depressions, weld seams, and similar spots to prevent high spots and deck irregularities from showing through the carpet and promoting premature wear.

(4) Ensure underlay is smooth, sanding any high or rough spots as necessary.

(5) Install the carpet by the tackless procedure or by cementing it to the primed deck with a water-based adhesive such as MIL-A-2106 adhesive or one recommended by the carpet manufacturer. Carpets may be installed so as to abut permanently installed fixtures and furniture, but otherwise shall cover the deck completely. A bright CRES or aluminum strip shall be installed where the carpet abuts other deck covering in foot traffic areas.

c. Minimizing Appearance of Soil. Special attention should be given to choosing the proper carpet color to reduce apparent soiling. Tweeds generally show soil less than solid colors. Medium-depth shades show soil less than lighter shades. Earth colors such as greys, browns, and greens are particularly good for their soil-hiding properties. Very dark shades show light-colored dust conspicuously and should be avoided near entryways and adjacent to hard floor areas. There is no way to keep carpets in regular use from getting dirty but the soiling rate can be retarded in many cases.

(1) Carpets shall be treated with a soil retardant treatment such as 3M Brand Carpet Protector or equal prior to use.

(2) Tracked soil can be greatly reduced by use of walk-off mats located at entrances and where carpet adjoins the deck tile. These walk-off mats may be selected from several types such as:

(a) A bound rug made from the same fabric as the carpet.

(b) A coir door mat (FED SPEC DDD-M-156).

(c) A safety rubber mat (MIL-M-15562).

(d) A rubber or plastic link mat (FED SPEC ZZ-M-46).

(e) A carpet runner of matching fabric especially for use at main entrances and in areas of very heavy traffic. Where fabrics are subjected to heavy abrasion from caster-wheeled chairs, protective pads or mats are recommended.

d. Routine Maintenance. A routine maintenance program is critically important in maintaining satisfactory carpet appearance. Almost all carpet cleaning consists of common sense practice of these cardinal rules:

(1) Frequent (daily to weekly, depending on traffic volume and location) vacuuming or sweeping of all areas.

(2) An upright vacuum cleaner of the motor-driven brush and beater type is essential for proper carpet care. A tank-type cleaner can be used for occasional touch-up work, but is not recommended as the principal cleaning equipment. The combination of a tank cleaner and a separate motor-driven brush-and-beater floor tool can be used to advantage. The tank cleaner can also be used with a vacuum wand to pick up loose surface dirt and to clean difficult-to-reach areas.

(3) Prompt removal of spills and attention to spots and smudges.

(4) Light cleaning of heavy-traffic areas with dry powder or foam as needed to prevent over-soiling.

(5) Daily vacuuming is often essential to reduce abrasion by sand and grit and, to prolong carpet life. In areas of extremely heavy foot traffic, it may sometimes be necessary to vacuum several times per day.

e. Spot Cleaning. Prompt attention to spills is important. They should be treated when they occur or when first discovered. Early blotting of liquid spills with a soft absorbent paper towel or cloth will reduce the probability of a permanent spot or stain developing. Regardless of the type of spill involved, there are certain basic procedures that should be followed in attempting removal. The following recommendations are suggested for spot removal:

(1) Soak up as much of the spill as possible with a towel.

(2) Before using any cleaning agent, try a small amount on an inconspicuous corner of the carpet to make sure the cleaner itself will not mark the fabric. For spills known to consist solely of water soluble or wettable materials, a detergent solution is the best cleaning agent. Dry cleaning fluid is usually effective for oily materials, paints, and lacquers. The proper procedure for the removal of a spot or stain of unknown composition is to try dry cleaning solvent first. If this is not successful, a detergent solution should be used. The detergent chosen should dry to a powder that can be easily vacuumed, thus not leaving a sticky residue that is apt to resoil.

(3) Apply a small amount of cleaning agent to the spot and remove the loosened material with a clean white towel. Take care not to overwet the area to avoid spreading the contaminant.

(4) Always start from the edge of a spot and work towards the center.

(5) Rub as little as possible. Rubbing has a tendency to spread the spot and distort the pile.

(6) Repeat the above procedures until spot has disappeared and place clean towel or absorbent tissue with weights over the treated area until dry.

(7) For chewing gum, wax, and other adhering materials, spray the spot with an aerosol products designed to solidify the contaminant. Immediately scrape off the brittle contaminant with a plastic spatula. The material can be solidified by freezing, using dry ice or ice cubes in a plastic bag. Spot cleaning with trichloroethane or other cleaning agent may be necessary to remove last traces of the spot. These techniques will remove almost all spots or stains. If the stain is rust or some other material that is not easily removed, spotting kits are available that can be used to remove such specific agents.

f. Major Cleaning. Over a period of time, every carpet will accumulate ground-in soil that cannot be removed by routine sweeping and vacuuming. A more rigorous cleaning method then becomes necessary. The importance of cleaning the carpet promptly when it begins to show soil cannot be overemphasized. Failure to do so will result in rapid deterioration of appearance and materially shorten effective life. After being cleaned, the carpet should not be walked on until completely dry. Major cleaning should usually be done once or twice a year. Actual frequency will depend on the traffic level, degree of preventive maintenance, carpet color, vacuuming efficiency, appearance level sought, and effectiveness of previous shampooings. Excessive shampooing will lead to premature carpet failure. Any of the following cleaning procedures may be used (for heavily soiled carpet, steam cleaning is recommended).

(1) Rotary Brush Shampoo. Rotary brush shampooing is the oldest and most widely used method of inplace carpet cleaning. It utilizes a shampoo machine which drives the detergent solution into the pile with a flat revolving brush. This action breaks the oil film on the fibers and releases trapped dirt particles. Some procedures call for wet vacuuming to remove dirt and water. In other procedures the carpet is allowed to dry, and the powdered detergent and dirt are then vacuumed away. This method can be quite effective when employed by a skilled operator. It has two disadvantages. It requires a relatively long drying time, and may result in some permanent pile or texture distortion of shags and high pile plush carpets.

(2) Dry Foam. In this method, liquid shampoo is generated into a foam and evenly distributed on the carpet. The foam is worked into the pile with cylindrical brushes. Soil removal is improved by immediately vacuuming the carpet with a wet vacuum pick-up unit (several foam machines have such units built in). Since the amount of moisture used in the method is small, the total drying time is reduced and the carpet can usually be returned to service in a shorter period of time. This method also has some disadvantages:

(a) Because mechanical action and flushing action are less vigorous than with the rotary brush, this method usually does not loosen as much imbedded soil.

(b) Initial surface brightening is usually less effective than with rotary brush shampoo, especially in very heavily soiled areas, and a repeat cleaning is sometimes necessary.

(3) Steam Cleaning. The term steam cleaning is a misnomer, because it is not steam but a hot detergent solution that is sprayed into the carpet by a controlled, high-pressure jet. Hot water and detergent penetrate deep into the carpet pile, breaking the oil film and loosening soil. The cleaning solution and its suspended dirt are extracted from the carpet almost immediately by means of a vacuum head located just behind the pressure jets.

(a) The advantages of steam cleaning are:

1 Immediate soil removal by a vacuum system which sucks up detergent solution and loosened dirt.

2 Minimum pile distortion or texture change because no pile brushing is involved. This is particularly advantageous for high pile plushes and shags whose textures can be easily distorted by vigorous brushing action.

3 Detergent buildup in the carpet pile, which may contribute to resoiling, is minimized.

(b) The disadvantages of steam cleaning include:

1 Somewhat slower cleaning in terms of covering a large area of carpeting in a relatively short period of time.

2 Higher cost than other methods.

(4) Dry Powder. In the dry powder method, a solvent-saturated absorbent powder is worked into the carpet tile by hand or by a revolving brush machine. After application, the wet powder is allowed to dry for a period, generally several hours, and then the carpet is vacuumed.

(a) Advantages. Minimizes texture and color changes and, prolongs time before wet cleaning becomes necessary.

(b) Disadvantages. Not as effective for cleaning badly soiled carpets particularly when dry clay-type soils are deeply imbedded in the pile surface.

g. Repair. After being placed into service, carpeting is subject to snags, burns, and fraying which require repair work.

(1) Snags. During carpet manufacture, extra long yarn ends may sometimes become curled into the pile, and escape inspection. Once in service, an occasional such tuft may rise (or sprout) above the pile surface. This sprout is not a snag and does not mean that the carpet is coming apart; it is necessary simply to clip the protruding end with scissors at the level of the pile surface. A snag may result when an object, such as a shoe with a protruding nail, catches a loop and pulls it up. In this case, too, the high loop should be cut off even with the pile. Never pull on high tufts or loops protruding from carpet surface, since this action can cause additional damage.

(2) Cigarette Burns. A burn that chars the carpet surface in a superficial way will clear up nicely with careful clipping of the blackened tuft ends, followed by use of a soapless cleaner (such as carbona) and water sponging. Severely burned spots need replacement. The burned area may be cut out and the damaged section repaired with a patch of the same carpet material, or a professional carpet repair service may be used.

(3) Frayed Ends or Seams. Repairing carpets and rugs with frayed edges, whipped outends, worn hems, or worn-out fringe is usually a job for the professionals. However, if repair is attempted, follow these rules: First, trim off the worn or frayed parts. Start where the damage is deepest or most severe. Use large sharp shears, a sharp knife, or a single-edge razor blade, and cut from backing side. Follow one of the crosswise or lengthwise yarns or ridges. If required, a CRES or an aluminum hold-down bar may be installed to prevent further fraying along the edges.

### E-17. Slip-Resistant Self-Adhesive Treads.

a. General. Slip-resistant self-adhesive treads have pressure-sensitive adhesive on their backs and can be installed satisfactorily over bare steel, wood, well-dried (minimum 48 hours air dry) paint and primers, deck tile, and all other deck coverings that are well adhered to the deck. All rust, grease, oil, and dirt must be removed. In addition, deck tile should be cleaned free of residual wax. Three treads with no space between should be installed at the head and foot of ladders, on each side of doors used for continuous traffic, and at both sides of doors in crew messing space (install over deck tile if present). This will protect the deck tile from excessive wear on either side of doors. Slip-resistant treads should not be painted or waxed as this drastically reduces their slip-resistant properties. To increase the traction on sheet or deck tile covering, slip-resistant treads should be cemented directly over the basic deck covering. Required materials are: silicon carbide treads conforming to MIL-D-17951, 6 by 24 inches, black, NSN 7220-00-205-0389; or, 24-inch roll, NSN 7220-00-205-0390; and a beading sealer, NSN 8030-00-264-3886.

b. Installation. This deck covering does not require a separate adhesive because the back has a pressure-sensitive adhesive protected by a plastic liner. To facilitate liner removal, rub the rough surface of a piece of the deck covering against the edge of the liner in the direction of removal. This will lift the edge, and the liner can then be removed easily. Apply the tread or sheet to the deck and roll with a weighted roller. To waterproof the edges, seal with beading sealer, MIL-D-17951. When installing sheet material, leave a 1/16-inch expansion space between adjoining sheets and between sheets and bulkheads of coamings. Traffic can be permitted over the area after the sealer has dried hard.

c. Repair. Replace damaged treads as follows:

(1) Over steel or aluminum, remove the damaged sections by scraping or chipping and mechanically abrade the deck to shiny metal. Reprime the deck and replace the treads as soon as surface is dry.

(2) Over deck tile or resilient sheet, remove as much of the tread as possible without damaging the existing tile or sheet material. Replace with new treads.

## E-18. Slip-Resistant Deck Covering

a. General. Slip-resistant (nonskid) deck coverings are used aboard ship to provide safe footing for personnel and a slip-resistant surface for vehicles and aircraft. Appendix A, Table A-2, lists color numbers and NSNs.

b. General purpose use interior and exterior types.

(1) General Purpose Use. A general purpose, abrasive-type nonskid coating is normally satisfactory for most shipboard applications.

(a) The majority of nonskid coating failures are caused by either improper application or application over a poorly prepared surface; either almost always leads to premature failure. Adhesion of nonskid materials, just as for other coatings, is dependent upon the degree of surface preparation and the environmental conditions under which they are applied. Application over a hot or cold surface will dramatically affect the cure time and workability of the nonskid material. When this covering is applied on a hot surface (over 37.8°C (100°F)) the cure time can be significantly decreased; on a cold surface (below

10.0°C (50°F)) on the other hand, the cure time will be significantly increased. Ideally, the nonskid system should be applied over a white or near white, abrasive-blasted surface, free from oil, grease, or other contaminants, and applied on a day when the relative humidity does not exceed 60 percent and the surface temperature ranges between 18°C and 29°C (65°F and 85°F).

(b) In addition, the nonskid coating should be applied over an approved primer. For steel, an epoxy primer, formula 150, MIL-P-24441, must be applied beneath the nonskid topcoat. The primer not only improves the adhesion of the nonskid coating but prevents rapid failure or undermining of the nonskid topcoat if it becomes cut, pierced, or otherwise mechanically damaged.

(2) Deck Areas (Metal - Interior and Exterior). For metal deck areas apply one of the following nonskid systems:

(a) Sprayable type, MIL-D-24483, type I.

(b) Rollable type, MIL-D-23003, types III and V, general purpose. Type III is intended for use aboard ship where a slip-resistant surface is needed, and on exterior walkways and weather decks. Type V is a high-flash point material, which makes it desirable for interior use or wherever application conditions require a low fire risk material. Type V requirements allow a shorter work time or pot life, and it is cautioned that some difficulty may be encountered if applied in warm weather.

c. Deck Preparation (Metal Decks). Many cases of nonskid coating failures have been the result of improper surface preparation or application. The degree of adhesion of a nonskid coating is directly proportional to the degree of surface preparation and cleaning. Reduction in the degree of surface preparation is usually accompanied by a proportionate reduction in performance. Various degrees of surface preparation specifically relating to gradations in performance have not been established, nor can they be assessed with any degree of confidence. There are also certain trade-offs, such as, cost, time, abrasive equipment availability, grit disposal, dust and machinery contamination which must be considered. Therefore, every effort should be made to achieve or approach the optimum surface within the constraints encountered in each situation. Ideally, the non-skid coating system should be applied over a metal surface which is free of corrosion products and other contaminants, degreased, and coated with the approved metal primer.

(1) Steel surfaces should be finished to a white metal finish (SSPC-SP5), or to a near-white metal finish (SSPC-SP-10), as defined in the Steel Structures Painting Manual, volume 2.

(a) Blast cleaning to white metal (SSPC-SP5) is the ultimate, and is used to prepare surfaces where the coatings must withstand exposure to very corrosive atmospheres and where a high cost of surface preparation is warranted. Blast cleaning to white metal, requires the complete removal of all rust, mill scale, and other contaminants from the surface.

(b) In a near-white metal blast (SSPC-SP 10), there may be shadows, streaks, discolorations, and blemishes across the blasted surface area, but not concentrated in spots. (Evaluation of cleaning results is based on visual examination.) A near-white preparation effects a 10 to 35 percent savings over a white metal blasting and has proven to be adequate for many of the special coatings developed for long-term protection in moderately severe environments.

(2) Aluminum surfaces shall be cleaned free of corrosion products, dirt, and other contaminants by light abrasive blasting with 80 grit aluminum oxide or garnet abrasive. A pressure of 65 psig has resulted in satisfactory surface preparation with minimal metal removal. The surface can be spot cleaned after blasting by power brushing or orbital sanding. Aluminum shall be cleaned only with clean, dry sand, stainless steel wire brushes, stainless steel pads, or P-D-455 specification abrasive sanding discs not used previously for cleaning other metals or for removal of copper or mercury pigmented paints. If not painted immediately or if contaminated with oil or grease, the aluminum should be washed with a liquid detergent cleaner (MIL-C-18687, type II, cleaning compound, biodegradable), thoroughly rinsed with freshwater, and allowed to dry completely.

d. Renewal and Reapplication. Nonskid surfaces must be renewed when operations indicate that slip resistance has become unsatisfactory as a result of wear or coating failure. Surfaces may be renewed by overcoating the existing coating; the decision to recoat should be based on a thorough examination. If the existing coating is worn but otherwise sound (intact), it can be successfully overcoated. Wear is shown by loss of nonskid characteristic (grit is worn flush with coating film); a sound surface condition is shown by relatively few bare areas, no significant rusting, no corrosive undercutting (indicated by easily removable nonskid flakes or sheets), and by good adhesion (indicated by difficulty in removing a test patch by chipping or scraping). If examination reveals large bare areas, significant corrosion or poor adhesion, the old nonskid coating should be removed and the surface properly prepared before reapplication of nonskid coating. The degree of adhesion of the new coating will depend on the quality of cleaning and surface preparation.

(1) A section of the deck should be roped off to eliminate nonessential traffic. The deck must be cleaned free from rust, oil, loose paint, and other contaminants by either mechanical or chemical means or, as combination of the two, degreased and coated with formula 150.

(2) In view of the time and effort required for surface preparation, care should be exercised to protect the surface by priming immediately (within 1 hour) after it is cleaned and dried in order to prevent rust and other surface contamination. Although priming within 1 hour is generally recommended, the priming of steel can often be delayed for longer periods without serious effects under favorable conditions; that is, conditions of low humidity and freedom from surface contamination, or when the surface can be certified to conform to a near-white blast, SSPC-SPC-10.

e. Recoating. Sound, intact, nonskid coatings may be recoated if the surface is lightly sanded or roughened, cleaned, and degreased. On areas where machinery is used, the surface may be degreased by scrubbing with a cleaning solution to remove grease, fuel, and hydraulic.

f. Complete Removal of Nonskid System. A portion of deteriorated nonskid coating or the complete nonskid coating system can be removed and the surface prepared for recoating by the methods described below.

(1) Surface Priming Metal. An anticorrosive primer is normally required over metal surfaces beneath the nonskid topcoat. Primer not only improves the adhesion of the nonskid topcoat, but enhances the total performance of the nonskid system. Formula 150, MIL-P-24441, an epoxy primer, is preferred and is recommended for use under all epoxy nonskid topcoats applied over steel or aluminum surfaces. For maximum aluminum corrosion protection and adhesion, apply an additional prime coat of MIL-P-23377 (approximately 0.5 mil DFT) over the aluminum (that is, beneath the coat of formula 150, MIL-P-24441).

(a) On steel, the primer should be applied 2- to 4-mils dry-film thickness over clean, dry metal that has been abrasive blasted to a white or near-white finish. On aluminum, primer shall be applied to a surface that has been cleaned, deoxidized and roughened. The primer should be applied as soon as practical after the metal is cleaned to lessen the possibility of surface corrosion and contamination.

(b) The practical spreading rate of formula 150 is approximately 150 square feet at 4 mils and 300 square feet at 2 mils.

(2) Packaging. Nonskid coating material is packaged in 5 gallons per kit. A kit consists of approximately 4.25 gallons of base material (which includes the resin and nonskid aggregate particles) and approximately 0.75 gallon of converter packed in a 1-gallon can. The base material and converter are packaged in a 6-gallon pail with a plastic divider between them. The gross weight of the kit is approximately 75 pounds.

(3) Mixing Instructions For All 5-Gallon Kits. Kits should be prepared as follows:

(a) Store nonskid pails upside down 24 hours before using, at temperatures between 10°C and 21°C (50°F and 70°F).

(b) Check after 15 minutes for leaks. If pail leaks, return to upright position.

(c) When ready to begin, turn pail right side up and open lid of the 6-gallon container. Remove 1-gallon can of converter.

(d) Remove plastic divider from inside the 6-gallon container to expose the base material.

(e) Thoroughly mix and stir base material, preferably with a mechanical mixer. Make sure all settled material is lifted off the bottom of the container and is uniformly mixed.

(f) Slowly pour contents of can of converter (hardener, accelerator, or curing agent) into base material. Scrape bottom and sides of converter can to ensure the complete contents are emptied into pail of base material. Mix converter and base material for 3 to 5 minutes or until mixed material assumes a uniform color and appearance. Scrape bottom and sides of pail to ensure complete mixing. Mix again for 3 to 5 minutes.

(g) Allow mixed material to remain in pail before use as indicated in the table E-3.

**TABLE E-3. STANDING PERIOD**

| Temperature of Mixed Nonskid Coating | Time |
|---|---|
| 10°C - 16°C (50°F - 60°F) | 1 Hour |
| 16°C - 21°C (60°F - 70°F) | 30 Minutes |
| Above 21°C (70°F) | 15 Minutes |

(h) Immediately after the standing period, stir again for 1 minute and start rolling application.

(4) Rollable Nonskid Coating Application. Following are procedures for applying nonskid coatings.

(a) Prior to rolling application of the nonskid material, prepare the deck surface and prime with formula 150 paint primer. Ensure that the primer coat is cured and clean.

(b) Use a long-handled roller applicator with a free-rolling, hard-phenolic roller core (napless), 9 inches long, 1-7/16 inch diameter, 3/32-inch thick, slip-off design. Roller cores may be obtained from:

American Abrasive Metals Company
460 Coit Street
Irvington, NJ 07111

and

Thomas Paint Applicator
P.O. Box 360
Johnson City, TN 37601
(Subsidiary of Thomas Industries, Inc.)

(c) Pour a puddle of nonskid on the deck surface up to 18 inches in diameter or in any convenient amount that can be spread with roller applicator.

(d) Roll, using several criss-cross strokes with a moderate amount of pressure on the roller handle to spread out the poured puddle evenly. As a final pass, roll in slow, straight strokes pulling the nonskid material toward you. Roll in only one direction to develop the proper ridge formation. Don't roll too fast, or you will throw off the excess nonskid. Do not overroll too many times nor press down too heavily. Be careful that material does not build up too thickly along welds (roll across welds, not along them) and around padeyes. Nonskid coatings applied too thickly may not cure properly.

(e) On smooth deck surfaces, 5 gallons of material should normally cover 175 to 200 square feet (approximately 35-40 square feet per gallon).

(f) Take into account the following factors:

1 Working life of mixed material varies with temperature and is approximately 4 hours at 24°C (75°F).

2 The pot life is 4 hours at 24°C (75°F) (when mixed with accelerator).

3 Hard Dry is reached after 24 hours at 21°C (70°F) to a foot-traffic stage and to a heavier traffic stage after 48 hours at 21°C (70°F).

4 Minimum cure time is 4 days at 21°C (70°F) (Complete Cure, Heavy-Duty vehicular traffic, aircraft movements).

5 The strength of the ridge formation should be tested before allowing foot traffic on newly-applied coatings.

6 Cure time of nonskid coatings is a function of the surface temperature. The higher the temperature, the sooner the cure hard condition will be reached. Conversely the cooler the surface temperature, the longer it will take to reach a cure hard condition. The surface temperature can be considerably higher or lower than the air temperature depending on the time of day and the amount of direct sun exposure. Excessively hot surfaces may cause nonskid coating defects. Excessively thick coatings will require longer cure times and result in defects, especially on hot surfaces.

(g) Cleaning. Clean tools and equipment immediately after application is completed by using solvents recommended by the manufacturer (such as toluol, xylol and alcohols) and observing proper handling precautions.

(5) Appearance of Cured Material (Surface Profile). When nonskid coatings have dried and cured, the surface profile will show a hard ridge pattern with a textured appearance of roughly parallel rows of raised coating peaks or ridges. The aggregate shall present a uniformly coarse, rough appearance over the entire surface. The overall surface appearance shall present a wave-like ridge pattern with raised peaks. The peaks of the waves shall be approximately ½ to 1 inch apart and approximately 1/16 to 3/32-inch high.

(6) Specific Application Guidelines. The following specific guidelines have proved successful under fleet and service conditions and are recommended for use when rollable nonskid coatings are applied.

(a) Keep a lid on all opened nonskid coating containers when not in use in order to minimize solvent losses.

(b) Overstirring nonskid coatings may cause breakdown of chemical thickening agents as well as introduce excess air that may inhibit or accelerate coating reactions.

(c) Do not apply nonskid coatings when deck temperatures are above 49°C (120°F) or below 4°C (40°F).

(d) Base material components from one manufacturer are not compatible with another manufacturer's accelerator component. Do not mismatch components; they are not interchangeable.

(e) Formula 150 paint primer should be mist sprayed or solvent wiped if more than 24 hours elapse between primer application and nonskid coating application.

(f) Nonskid deck coatings are high-performance, organic coatings that are designed to be applied over Navy formula 150 Paint Primer.

(g) When nonskid coatings are mixed and not immediately applied, they should be remixed for a period of 1 to 2 minutes before application.

(h) Nonskid coatings must be thoroughly mixed to disperse components. Mix only that amount that can be applied during the working life of the coating. Never mix more than can be used in an 8-hour work day. All coating that is mixed shall be applied.

(i) Nonskid coatings are best applied in one continuous operation.

(j) Condition the roller core before applying the nonskid coating by wetting its surface with some freshly prepared mix. Don't allow the coating to dry or build up on the roller applicator.

**E-19. Safety Precautions.** All the compounds mentioned in the discussion of slip-resistant deck coverings contain volatile solvents which may be flammable. Adequate safety precautions must be observed during application.

a. It should be noted that some individuals are more sensitive than others to the materials and may develop a skin rash. To prevent this possibility, gloves shall be worn. If materials are spilled on the hands or other parts of the body, they should be wiped off and the skin washed with soap and water. In case of accidental contact with the eyes, flush the eyes immediately with clear water and contact a physician. Clothing and gloves contaminated with the uncured resins shall not be worn again until they have been thoroughly cleaned. Adequate exhaust ventilation is necessary where these materials are used in closed spaces to prevent hazards due to solvent entrapment. If the proper precautions are taken to insure cleanliness, ventilation, and protective clothing, no difficulty should be encountered during the use or handling of epoxy resins, hardeners, or solvents.

b. Where non-skid materials are rolled, troweled, or sprayed, the following safety precautions shall be observed for a minimum of 1 hour after the nonskid has cured.

(1) Insure absence of any ignition source; all welding, hot work, open flames, energizing and de-energizing electrical circuits in the compartment and adjacent areas shall be prohibited. Only explosion-proof lights shall be used and all portable electrical wiring shall be inspected for cracks and wear prior to use.

(2) Use exhaust ventilation, preferably air-driven, to open air to reduce the solvent vapor concentration below the lower explosive limit. Ship's exhaust ventilation in the area shall be secured and masked; air supply shall be left open. If it is necessary to use electrical motor-driven exhaust fans, only explosion-proof equipment shall be used. Ground all exhaust ventilation for electrostatic discharge, using approximately AWG 20 cable with metal clips for attaching equipment to ground.

(3) Portable dry chemical fire extinguishers shall be readily available.

(4) The requirements of certification by a gas free engineer, shall be followed with regard to maintaining a safe atmosphere.

(5) Personnel protective clothing and eye protection shall be worn.

(6) Where the foregoing safety precautions cannot be implemented, install 6-inch by 24-inch slip-resistant treads, MIL-D-17951 (NSN 7220-00-205-0389), approximately 3 inches apart over entire work and traffic areas, or cut and install sections from a 24-inch wide slip-resistant roll (NSN 7220-00-205-0390).

## E-20. Cleaning of Shipboard Deck Covering.

a. General Precautions. Few materials aboard ship receive as much wear and cleaning as deck coverings. Rough and improper maintenance will quickly destroy the appearance and durability of these materials and lead to expensive replacement. Adherence to the rules and procedures given herein will improve appearance and prolong the life of deck coverings.

(1) The most painstaking and careful maintenance of deck coverings may be wasted if the legs of furniture, especially chairs and other movable pieces, are not properly equipped with rubber tips to prevent scratching and denting of resilient deck covering surfaces. Nonslip rubber tips are available under NSN 5340-00-825-6503.

(2) Avoid dragging heavy objects across unprotected resilient deck covering.

(3) If at all possible, avoid using salt water on interior decks.

(4) Do not use an excess of water, strong alkaline soaps, strong alkalis, lye, rough abrasives, very hot water, or steam on interior deck coverings.

(5) Except for use of cosmetic coatings never paint, varnish, or shellac any deck covering.

(6) Protect decks with cover cloths during painting of bulkheads and overheads.

(7) Protect deck coverings with scrap materials or heavy Kraft paper during shipyard overhauls and other repairs.

(8) Wash deck coverings no more frequently than necessary for appearance or sanitation.

b. Materials and Equipment. Cleaning of shipboard deck coverings necessitates use of diverse materials and equipments, depending on application.

(1) Synthetic detergent cleaning solution. The following cleaning solution should be used, except as otherwise specified herein: 1 to 4 ounces of detergent per gallon of warm, potable water. Rinse water should also be potable water. Do not use any other strongly alkaline cleaners, except as specified herein.

| | |
|---|---|
| Synthetic Non-Abrasive Detergent, P-D-220 | NSN 7930-00-530-8067 (1-gal.) or 7930-00-527-1237 (5-gal.) |
| Liquid Heavy-Duty Synthetic Detergent, P-D-223 | NSN 7930-00-515-2477 (1-gal.) or 7930-00-526-2919 (5-gal.) |

(2) Floor polishing and scrubbing machine, Fed Spec 00-P-570, NSN 7910-00-680-8297.

(3) Liquid sealer for terrazzo decking, NSN 8030-00-007-8333 (1 gallon) and NSN 8030-00-007-8334 (5-gallon).

(4) A slip-resistant water-emulsion-type floor wax is available under Stock Number 7930-00-205-2870. This wax should be applied in a very thin coat and allowed to dry 30 minutes before traffic is permitted on it and, before polishing. It is a self-polishing wax, but the gloss of even the best of this type is improved by buffing after drying. A nonbuffing, slip-resistant, water-emulsion floor polish may be obtained under the following stock numbers:

NSN - 7930-00-926-1688 (1 gallon)
NSN - 7930-00-926-1689 (5 gallon)
NSN - 7930-00-926-1687 (55 gallon drum)

**By Order of the Secretary of the Army:**

**JOHN A. WICKHAM, JR.**
***General, United States Army***
***Chief of Staff***

**Official:**

**R. L. DILWORTH**
***Brigadier General, United States Army***
***The Adjutant General***

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CO A, 3d ENGINEER BN
FT. LEONARDWOOD, MO 63108

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PUBLICATION DATE: 9 Mar 87
PUBLICATION TITLE: Painting of Vessels

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|---|---|---|---|---|
| 6 | 2-1 a | | | In line 6 of paragraph 2-1a the manual states the engine has 6 Cylinders. The engine on my set only has 4 Cylinders. Change the manual to show 4 Cylinders. |
| 81 | | 4-3 | | Callout 16 on figure 4-3 is pointing at a bolt. In key to figure 4-3, item 16 is called a shim - Please correct one or the Other. |
| 125 | line 20 | | | I ordered a gasket, item 19 on figure B-16 by NSN 2910-00-762-3001. I got a gasket but it doesn't fit. Supply says I got What I ordered, so the NSN is Wrong. Please give me a good NSN |

PRINTED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER: JOHN DOE, PFC (268) 317-7111

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## The Metric System and Equivalents

### *Linear Measure*

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

### *Weights*

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

### *Liquid Measure*

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

### *Square Measure*

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

### *Cubic Measure*

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

## Approximate Conversion Factors

| *To change* | *To* | *Multiply by* | *To change* | *To* | *Multiply by* |
|---|---|---|---|---|---|
| inches | centimeters | 2.540 | ounce-inches | newton-meters | .007062 |
| feet | meters | .305 | centimeters | inches | .394 |
| yards | meters | .914 | meters | feet | 3.280 |
| miles | kilometers | 1.609 | meters | yards | 1.094 |
| square inches | square centimeters | 6.451 | kilometers | miles | .621 |
| square feet | square meters | .093 | square centimeters | square inches | .155 |
| square yards | square meters | .836 | square meters | square feet | 10.764 |
| square miles | square kilometers | 2.590 | square meters | square yards | 1.196 |
| acres | square hectometers | .405 | square kilometers | square miles | .386 |
| cubic feet | cubic meters | .028 | square hectometers | acres | 2.471 |
| cubic yards | cubic meters | .765 | cubic meters | cubic feet | 35.315 |
| fluid ounces | milliliters | 29,573 | cubic meters | cubic yards | 1.308 |
| pints | liters | .473 | milliliters | fluid ounces | .034 |
| quarts | liters | .946 | liters | pints | 2.113 |
| gallons | liters | 3.785 | liters | quarts | 1.057 |
| ounces | grams | 28.349 | liters | gallons | .264 |
| pounds | kilograms | .454 | grams | ounces | .035 |
| short tons | metric tons | .907 | kilograms | pounds | 2.205 |
| pound-feet | newton-meters | 1.356 | metric tons | short tons | 1.102 |
| pound-inches | newton-meters | .11296 | | | |

## Temperature (Exact)

| | | | | |
|---|---|---|---|---|
| °F | Fahrenheit temperature | 5/9 (after subtracting 32) | Celsius temperature | °C |